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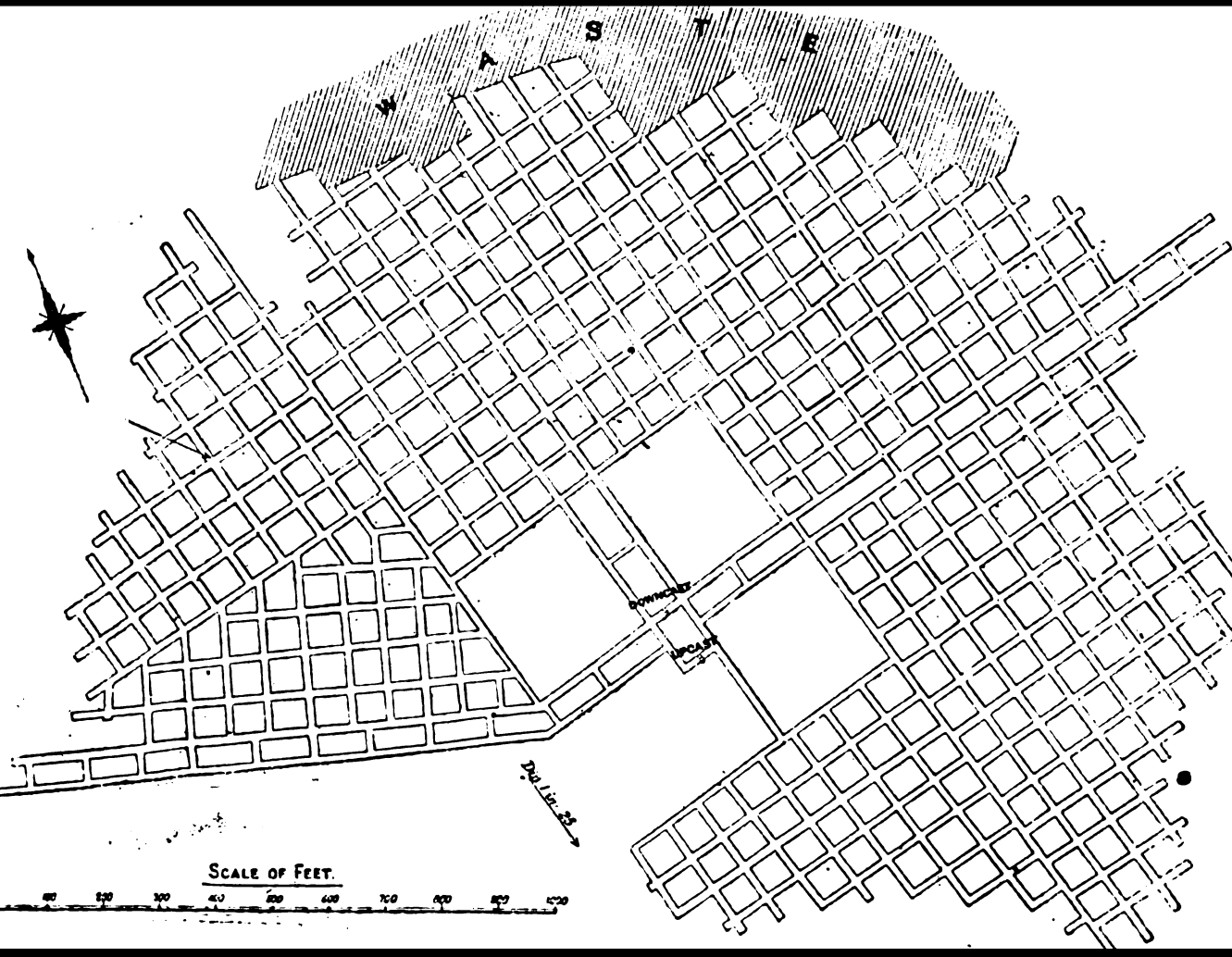

Mining

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"MINING,"

AN ILLUSTRATED PAPER DEALING EXCLUSIVELY WITH THE INTERESTS OF THE MINING COMMUNITY.

VOLUME IV.---1895-96.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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THE INSTITUTION OF CIVIL ENGINEERS.

THE first meeting of the Session 1895-96 was held on Tuesday, November 12th, when a portion of the new building, comprising the Theatre and approaches, with tea room, etc., was made available for the purposes of the evening. The chair was taken at 8 o'clock by Sir BENJAMIN BAKER, K.C.M.G., LL.D., F.R.S., the new President, who delivered his inaugural address. After some preliminary observations referring to the position of the Institution in the domain of engineering, and the necessity of British engineers acting together in a true spirit of comradeship throughout the world, the President proceeded to discuss the question why engineering, unlike other liberal arts, was an essentially modern profession. Was it because the modern demand for rapid transit, often as purposeless as that of a record-breaking bicyclist, had not its equivalent in the past, or was it because our ancestors lacked the inventive power and mechanical ingenuity of the present age? The artificers who built the highly ornamental barge in which Columbus blundered across the Atlantic could, with the same materials and workmanship, have constructed a clipper ship capable of sailing 300 miles in a day, but no one asked for speed in those days. On the other hand, although the present was pre-eminently an age of invention, an impartial survey of actions and events recorded in history would satisfy most people that in all ages there were to be found men no less intellectual and enterprising than ourselves. The general answer to the question raised would probably be that as it was only in the present century that people had insisted upon rapid locomotion by land and water, so it was the necessity of meeting that demand which had created the profession of modern engineering. When Watt directed his attention to the steam-engine, the country was weary of wars, and longed for the advancement of its material prosperity, and so a demand was created, and the country quickly became covered with canals, roads, and factories. At that time England depended largely upon her American colonies (now the United States) for the supply of iron, and in 1751 an Act was passed admitting American bar iron duty free to London, but prohibiting its cartage therefrom to Birmingham, as it was desired to make London, instead of Birmingham, the chief seat of the iron manufacture of the country. No one foresaw that Great Britain was to become the leading iron-producing country of the world. On all subjects, indeed, the most eminent men constantly failed in their forecasts. Smeaton did not believe in the steam-engine as proposed by Watt; Telford had grave doubts as to the practicability or usefulness of the Liverpool and Manchester Railway; Sir Robert Peel, sixty years ago, blocked a proposal in Parliament to make all the railways seeking access to London adopt a comprehensive plan for a a central exchange station, so that through passengers and mails might be saved cabbing across London; Lord Brougham tried, in 1857, to make 30 miles an hour the statutory limit of speed on railways; Lord Palmerston told the House of Commons that the Suez Canal was one of those bubble schemes often set on foot to rob the English capitalist, and even Robert Stephenson, following him, declared it to be, commercially speaking, impracticable. All these mistakes, however, became insignificant when contrasted with the gigantic blunder, acquiesced in by the whole civilized world, of assuming, at the time of the Great Exhibition of 1851, that the efforts of the engineer would effect an immediate change in the long inherent savagery of mankind, thereby inaugurating a period of universal brotherhood and peace. Civil Engineers were often reproached for devoting their ingenuity to the devising of man-killing appliances, but with little reason, for no one could fail to see that whatever might be the abstract principles of Christianity, in practical

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politics they were disregarded, it being always taken for granted that if a nation possessed that which another nation might covet, it must be prepared to defend its possession at the point of the sword.

It had been frequently assumed that everyone acknowledged the benefits conferred upon humanity by engineers in facilitating communication, cheapening production, and raising the condition of the toiler; but the late Professor Froude had publicly stated that he failed to see much evidence of progress in the nature of men, and that "Even in the outward essentials of food and clothing and housing it is not certain that the mass of mankind in the present generation are better off than their forefathers." The president was not prepared to accept this dictum, and maintained, on the contrary, that the mass of mankind were much better off than their forefathers in these respects. Further, that the independence of the labourer and mechanic had been greatly advanced in consequence of the vastly increased demand upon their services due to engineering work. In support of this view, it was stated that as recently as four years after the opening of the Liverpool and Manchester Railway, certain Dorsetshire labourers ventured to erect themselves into an elementary form of trade union, and were sentenced to seven years' penal servitude for their pains. At the present time many municipal contracts provided for payment of wages at trade-union rates, whereas a couple of centuries ago, the magistrates fixed the rate at Quarter Sessions, according to the price of food and clothing, the average being about 1s. a day for carpenters and masons, and 8d. for labourers. The hours of labour for all classes were from 5 a.m. till 8 p.m. with 2½ hours interval for meals and rest. The penalty for an employer who departed from these regulations was ten days' imprisonment and £5 fine, and for a workman twenty-one days' imprisonment. No man in search of work could beg without a license, the statutory penalty for a first offence being whipping at a cart's tail; while the second offence meant the loss of an ear and two days' scourging, and the third hanging. On the whole, the study of the past was conclusive as to the material and moral progress which had accompanied the development of engineering works.

The President next dwelt upon the work done by physicists in the borderland of engineering, and expressed the opinion that long before the coalfields were exhausted some way would have been discovered of tapping the inconceivably great reservoirs of force in nature still untouched. Although no one could foresee the demands of the next age, new wants constantly arose, and new branches of engineering often resulted from apparently trivial laboratory experiments.

In conclusion, the President sounded a note of warning against the growing disposition to overrate technical education. Education would do much, but it would not endow a man with common sense, nor would make his opinion on a multitude of important subjects worth more than that of any naturally observant person. There were not wanting contractors and manufacturers who contended that some of the highly-trained young engineers of the present day were not wholly free from a tendency to over much reliance on formulas, without due regard to the sufficiency of the data upon which such formulas were based. Such faults were best remedied by joining in practical discussions with other engineers, such as it was a province of the Institution of Civil Engineers to encourage.

DONAHUE'S EDUCATOR DIAL.

Candidates for the Colliery Managers' Examinations who have not the opportunity of studying mine surveying in a practical manner find the greatest difficulty in acquiring a sufficient grasp of the subject to enable them to correctly answer the questions given. In the majority of cases surveying apprentices also are debarred from handling a dial for the first few years of their term of apprenticeship and much valuable time is wasted, whereas the apprentice might have acquired a considerable insight into his profession by the use of an instrument. The price of ordinary dials makes them prohibitive for educational purposes and a cheap instrument has been much wanted. Messrs. J. Halden & Co., Instrument Makers, of London and Manchester, have for some time past made a speciality of students' instruments, and they are now manufacturing a cheap dial for educational purposes. The dial is so constructed that the exact principles of the ordinary dial are reproduced, but the form is sufficiently modified to enable it be made at a very low cost. It is strongly made of vulcanite, and is pivoted on a suitable stand of wood. The graduated face is full size (5 inches diameter), the sights are of the ordinary folding description, and a true magnetic needle is provided. The cost of the dial (complete) is 13s. 6d., and its use is recommended by surveying instructors. The dial will without doubt prove a boon to mine surveying students, and the low cost places it within reach of all. The one now on the market is designed for loose needle surveying only.

In calculating the horse-power of steam boilers, allow for Tubular Boilers, 15 square feet of heating surface for one horse-power: Flue Boilers, 12 square feet of heating surface for one horse-power; Cylinder Boilers, 10 square feet of heating surface for one horse-power.

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THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.
Assistant M.E.

(Commenced in No. 9, Vol. III.)

BANKING ARRANGEMENTS.—Continued.

TO deal with large outputs at bank it is essential that the tubs be conveyed continuously round, always moving in one direction, and not, as is often the case, be subjected to all manner of intermittent backward and forward motions. Some managers still persist in having the heapstead practically horizontal, with the exception of a slight inclination in favour of the tubs at the shaft, and thus necessitate the employment of numerous workpeople to push the wagons about the heapstead, whereas by a judicious arrangement of gravity roads and the employment of a creeper chain, or elevating table, the tubs could be circulated with very little manual labour.

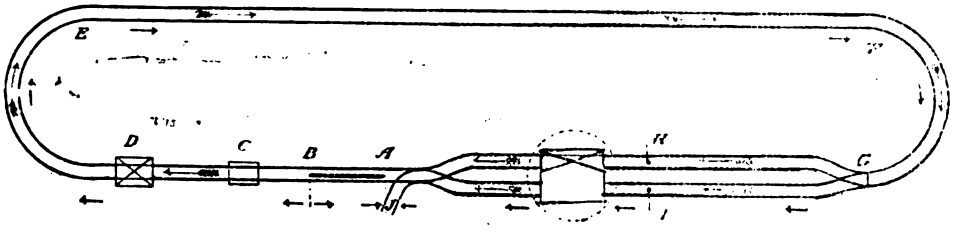

Fig. 53.

Fig. 53 shows a possible arrangement of the tram roads by means of which the manual labour is reduced to a minimum. The tubs circulate in the direction shown by the arrows in the centre of the tram roads, and the direction of inclination of the road is indicated by the small tail-less arrows. It will be seen that the inclination of the road is in favour of the full tubs as they leave the cage, and they gravitate to the point A, where they are caught singly by a creeper-chain, A B, and are carried up an incline to the point B; having reached the top of the incline they are liberated, and as the inclination here changes in favour of the tubs they travel on to the weigh-table, C, where they may be automatically stopped by the tub controller previously described and illustrated (see fig. 48, No. 25, Vol. III), or by the person who reads the checks, sufficiently long to enable weighing to be performed. The tub then gravitates to the tippler, D, where its contents are dumped and the next tub pushes it through the tippler and it gravitates round the curves, E F, back to the other side of the shaft to be again put into the cage. At the point G the return road branches into two, and the empty tubs may be directed into either by means of the points which are worked by a lever by the attendant at the shaft. At the points H and I, in the empty road, Woodworth's tub controllers are fixed, the levers of which are placed in connection with the cage keps so as to automatically deliver the empty tubs to the cages. The bye-road J, is intended for a rubbish road. With such an arrangement 1000 tons could be effectually dealt with, though in most cases more than one tippler is used for such a quantity, and oftentimes there are two different qualities of coal being wound in the same shaft. If, therefore, two tipplers were required, the arrangement would need little modification. The weigh-table might be placed nearer the shaft and the tubs weighed before being raised by the creeper-chain. From the weigh-table the road might branch into two, each provided with a creeper-chain; the tubs to travel along these to the two tipplers, and the two empty roads past the tippler to be again united to a single return road back to the shaft. The inclination of the roads is in favour of the tubs in every case except for the short distance traversed by the creeper-chain, so that sufficient height must be gained by the aid of the creeper-chain to allow the tubs to gravitate along all the other portions of the road.

Assuming the adoption of such an arrangement as fig. 53 in conjunction with the self-acting cage, previously described, the cost of labour would be very small, and there can be no objections on the score of complications or delicacy of the appliances as there is very little liability of anything getting out of order, as the only working appliances are the creeper-chain, Woodworth's tub controllers, and the automatic tub-stop of the cage, none of which are of very delicate construction.

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To deal with 800 tons per day certainly not more than five men and one boy would be required—one man to manipulate the keps, etc., of the cage, one at the weigh-table, two at the tippler, a boy for the tallies or workmen's checks, and a man to remove the rubbish and assist the man at the shaft. This would give a total cost of about 22s. per day, or ·33d. per ton. With the employment of two tipplers another man or perhaps two would be required, but 1000 tons could be easily dealt with, and the cost per day would be, say 30s., or about ·36d. per ton.

case the tippler governs the supply of tub to the switch-back C D, and there is in consequence sufficient time for the one tub to leave the switch-back before the next reaches it, and by having the creeper-chain near the extremity of the return empty road, as shown, the supply of tubs to the switch-back E F is also controlled. By reason of the switch-backs at the two extremities in this arrangement the same quantity of coal could not be dealt with as in the one previously described, but nevertheless a large number of tramscould be circulated and the cost of labour would not be any greater than in the first instance.

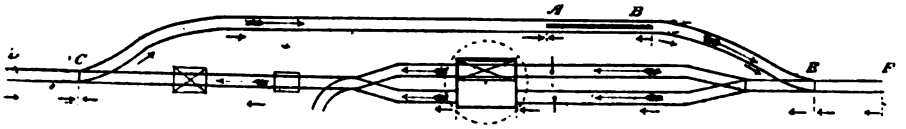

Fig. 54.

The arrangement of tram roads illustrated by fig. 53 would undoubtedly require a heapstead of considerable extent, but the arrangement can be much modified and the requisite space considerably reduced. In the first place, the creeper-chain could be fitted in the return road, as in fig. 54. The only advantage derived by having it as shown in the full road is that height is gained for the screening, and, therefore, this would be the more suitable position for those collieries which are modifying their heapstead arrangements, but for original constructions there is little difference. The curves also take up considerable space, but for these can be substituted switch-back arrangements with spring points as shown by fig. 54. The inclination of the roads is in favour of the tubs from the shaft to the tippler, and from thence to C. At the point C the inclination changes to a rise to D, but the momentum acquired by a tub in gravitating down the incline from the tippler to C is sufficient to carry it past the spring points at C and part way up the incline C D. The momentum of the tub being expended, however, it returns back from D to C, but the spring points at C being against it, it travels into the empty road and gravitates to A, when it is caught by the creeper-chain A B and carried to the top of the road which rises from A to B. The tub is liberated at the point B and travels to E, part way up the switch-back E F and back to the shaft. The only precaution to be taken in such an arrangement is that the tubs do not foil each other at the switch-backs. The arrangement shown in the sketch will ensure correct working, for in the one

In fig. 55, practically the same princi es are adopted, but a possible arrangement is shown where the tippler is situated at right angles to the delivery of the cages from the shaft. A description is unnecessary, as it is clearly illustrated.

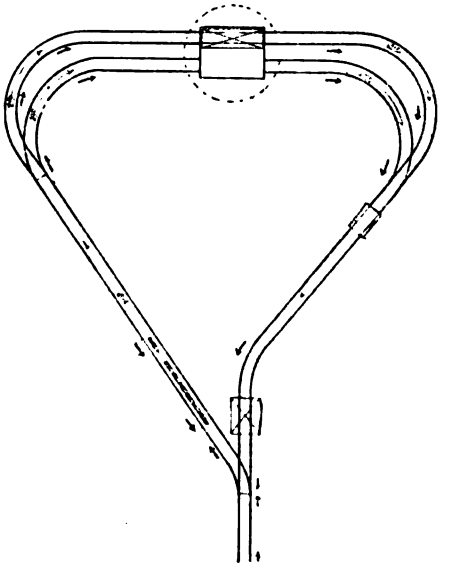

Fig. 55.

Many persons object to so much automaticism as has been described, but it is an indisputable fact that such arrangements are daily coming into more general use, and the instances cited are not ideal but present working arrangements given in a general form. The writer is, however, of opinion that it can be overdone. A case in point:—At one particular colliery the keps are auto-

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matically adjusted, the tubs run on to a platform which is elevated to a height of a few feet, the lever to admit steam to the piston having been worked by the tub in its passage on to the platform. When the platform has been raised the necessary height the tubs are discharged and pass on to the tippler, the platform in the meantime having descended to its original position, being knocked off automatically. On reaching the tippler the full tub pushes out the empty one, and the tippler being worked by power, tips the coals, the empty tub is then pushed out of the tippler by the succeeding full tub and gravitates back to the shaft, where tub controllers regulate the supply of empty tubs to the cage, and the whole operation is performed with practically no manual labour whatever. This is carrying matters to a fine point to a certainty, but as the whole is working satisfactorily, and has been doing so for some considerable time, no objection can be taken to it.

(To be continued.)

THE MINING ASSOCIATION OF GREAT BRITAIN.

A meeting of the Executive Council of this Association was held at the Westminster Palace Hotel, London, on Wednesday, November 25th, 1895. In the unavoidable absence of the president (Mr. A. Currer Briggs), the chair was occupied by Sir John Alleyne, Bart. The following members were present: Messrs Alfred Hewlett, W. Johnson, T. D. Grimké-Drayton, C. F. Clark, W. S. Barrett, Ralph Fletcher, George Bond, G. C. Bond, A. G. Barnes, Walter Salmond, Henry Lewis, W. Spencer, Fitzherbert Wright, M. Lyon, C. H. Oakes, F. C. Corfield, F. Parker Rhodes, C. Tylden Wright, Robert Eddison, F. J. Jones, R. I. Critchley, Ben. Day, A. Hood, John Williamson, and T. Ratcliffe Ellis (law clerk and secretary).

The first business on the agenda was the consideration of the forms of notices and returns as to accidents in and about mines, which had been issued by Her Majesty's inspectors to coal owners throughout the country, and which they desired to have made to them in future, in connection with accidents. Communications were read on the subject which had been received from the various local associations, and after a lengthy discussion, the following resolution was unanimously passed:—"That the secretary's report to this meeting—that it is not incumbent on coal owners to furnish the detailed information as to accidents, now required by the inspectors of mines,—be communicated to all the members of the association, calling their attention to the fact that it is undesirable, in the opinion of the council, to go beyond the requirements of the existing law." It was further resolved that a copy of the resolution should be forwarded to each member of the association. An informal discussion took place on the subject of railway rates, with special reference to the recent decision of the Railway Commissioners in the cases against the Midland Company.

The Law Clerk submitted a report which he had prepared on the subject of employers' liability, in consequence of the statement made by the Home Secretary to the Trade Union deputation which recently had an interview with him, showing the present position of the matter. It was resolved that the Home Secretary be asked to receive a deputation from the association, in order that the views of the coal owners might be submitted to him before he prepared his draft bill on the subject.

MASKELL PEACE MEMORIAL.—It was resolved that the districts comprised in the scholarship scheme be reduced to six, that the subscription list—which amounted to £1,065 5s. 7d.—be closed, and that the scheme be completed under the direction of the committee originally appointed to deal with the matter.

A vote of condolence with the widow and family of the late Sir G. W. Elliot, Bart., M.P., who was for many years a member of the council, was passed, and the secretary was instructed to forward a copy of the same to the proper quarter.

A vote of thanks to Sir John Alleyne for presiding was unanimously passed, and the proceedings terminated.

SUBSCRIPTION RATES.

We will forward our journal, post free, to any part of the United Kingdom, America, France, Belgium, Canada, Austria, Germany Spain, Italy, Russia, &c., at the following terms:—

Twelve Months -	**3s. 6d.**
Six Months - -	**2s. 0d.**
Three Months - -	**1s. 0d.**

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RAILWAY RATES ON COAL.

(Specially written for this Journal.)

CONTINUED FROM LAST ISSUE.

PART III.

IN the case of the coal owner it may fairly be claimed that he is entitled to special consideration on many grounds, amongst which may be named the fact that he collects for, and practically guarantees to the railway companies their toll accounts.

What the coal trade contended for before the Board of Trade and Parliament, was, that there was no justification for the railway companies increasing their rates, and they pressed that the rates for coal and slack should be differentiated, that is to say, that, whatever maximum rate was fixed in respect of coal, the rate for the conveyance of slack should be a lower one, but now that Parliament has seen fit to place both articles in the same class, and make them subject to the same rate, the coal owners throughout the country feel that a lower initial figure should be fixed as the maximum on class A traffic, or that, at all events, coal traffic should be made the subject of a lower rate. It is generally believed that if a figure could be agreed upon between the 0·875d. and 0·95d. it would be a fair and reasonable compromise, and would bring about a settlement of the existing controversy. Such an arrangement would be most satisfactory to the coal trade and would not, it is believed, work to the detriment of the railway companies.

There are other powers vested in the railway companies under their new Acts, to charge for services rendered and appliances provided, and it will be readily understood that they are amply provided for in regard to charging powers.

The Rates and Charges Acts define the "maximum rate for conveyance" to be

> "the maximum rate which the Company may charge for the conveyance of merchandise by merchandise train; and, subject to the exceptions and provisions specified in this Schedule, includes the provisions of locomotive power and trucks by the Company, and every other expense incidental to such conveyance not hereinafter provided for,—*Provided that the provision of trucks is not included in the maximum rates applicable to merchandise specified in Clause A of the classification.*"

Thus it will be seen that the maximum rates for Class A traffic given in Part II. of this paper are the rates *in owners' wagons.* If a railway company supplies wagons they would be entitled to charge any sums not exceeding the following:

	s.	d.	
For distances not exceeding 20 miles..	0	4½	per ton
For distances exceeding 20 miles, but not exceeding 50 miles	0	6	,,
For distances exceeding 50 miles, but not exceeding 75 miles	0	9	,,
For distances exceeding 75 miles, but not exceeding 150 miles	1	0	,,
For distances exceeding 150 miles	1	3	,,

The terminal charges are under two heads, viz: *Station* terminals and *service* terminals, the first-named being in respect of the use of accommodation provided by a railway company, and of duties undertaken by the company at the terminal station, and for which no other provision is made in the Schedule; and the second being in respect of the following services when rendered to or for a trader, that is to say, loading, unloading, covering and uncovering merchandise, and these charges are, in respect of each service, to be deemed to include all charges for the provision by the company of labour, machinery, plant, stores, and sheets.

With regard to these service terminal charges, there is a provision that where merchandise conveyed in a separate truck is loaded or unloaded elsewhere than in a shed or building of the company, the company may not charge to a trader any service terminal for the performance by the company of any of the said services *if the trader has requested the company to allow him to perform the service for himself and the company have unreasonably refused to allow him to do so.*

Any dispute between a trader and a railway company under this head is to be determined by the Board of Trade. The Rates and Charges Acts further provide that the railway companies may charge for certain services—which are enumerated,—when rendered to a trader *at his request or for his convenience,* a reasonable sum, by way of addition to the tonnage rate; any difference to be determined by an arbitrator to be appointed by the Board of Trade at the instance of either party, but it is provided that where, before any service is rendered to a trader he has given notice in

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writing to the company that he does not require it, the service shall not be deemed to have been rendered at the trader's request or for his convenience.

The services enumerated are :—

(1) Services rendered by the Company at or in connection with sidings not belonging to the company (*i.e.*) at private sidings.

(2) The collection or delivery of merchandise outside the terminal station.

(3) Weighing merchandise.

(4) The detention of trucks, or the use or occupation of any accommodation before or after conveyance, beyond such period as shall be reasonably necessary for enabling the Company to deal with the merchandise as carriers thereof, or the consignor or consignee to give or take delivery thereof; or, in cases in which the merchandise is consigned to an address other than the terminal station, beyond a reasonable period from the time when notice has been delivered at such address that the merchandise has arrived at the terminal station for delivery—and services rendered in connection with such use and occupation.

(5) Loading or unloading, covering or uncovering merchandise comprised in class A or class B of the classification.

(6) *The use of coal drops.*

(7) The provision by the Company of accommodation at a waterside wharf and special services for loading or unloading into or out of vessels.

There is a provison that where merchandise is conveyed in trucks not belonging to the company, the trader shall be entitled to recover from the company a reasonable sum by way of demurrage for any detention of his trucks beyond a reasonable period. Where merchandise is conveyed in a trader's truck (as in the case of coal) the railway company may not make any charge in respect of the return of the truck empty, provided that it is so returned from the consignee and station or siding to whom and to which it was consigned loaded, direct to the consignor and station or siding from whom and whence it was so consigned, nor is any charge to be made in respect of any empty truck which is sent over the railway for the purpose of being loaded, provided it is returned loaded from the station to which it is sent.

Section 31 of the Railway and Canal Traffic Act, 1888, provides that complaints of unreasonable charges, or oppressive or unreasonable treatment by railway companies are to be made in the first instance to the Board of Trade, and if the Board of Trade think that there is reasonable ground for the complaint, they may call upon the railway company for an explanation, and endeavour to settle amicably the differences between the complaint and the railway company. Failing relief under the section last named the course to be adopted by a trader who was aggrieved would be to file an application in the Court of the Railway and Canal Commission. The Railway and Canal Traffic Acts of 1888 and 1894, together with the Rates and Charges Act, relating to any railway company may be obtained from the Queen's Printers, or from Messrs. King and Son, Parliamentary Booksellers, 12, King Street, Westminster.

(*Concluded.*)

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before December 13th, 1895.

We invite readers to forward questions for this competition.

(1) State definitely and briefly the conditions aud circumstances which conduce to the advantageous working of a seam by pillar and stall or longwall, and also the conditions in the latter case which determine whether the working face should be straight or stepped, or on the cleat or end ?

(2) A gob fire is stopped off by two stoppings in the intake and return. On which side of each wall is the greatest pressure ? Give reasons for your answer.

(3) How would you work a mine 5 feet thick, with a strong metal roof and little packing material, and dip 1 in 3 ? Give sketch ; also show how the timbering of the working places should be effected.

If communications are forwarded understamped the letter will be refused.

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THE PRACTICAL SINKING AND TUBBING OF SHAFTS*

By J. P. HOUFTON.

IN choosing the site of a colliery or collieries which are intended to win a certain royalty, the following facts and conditions must be taken into consideration:—1. The size and shape of the royalty. 2. The dip and strike of the seams to be worked. 3. The direction of any large faults known to intersect the coalfield. 4. The position of any railways running through or across the royalty. 5. The relative levels of the surface to the railways.

Perhaps it will make this more clear if I take an actual example of a royalty of about 8,000 acres, showing its shape, the position of railways upon it, and the sites chosen for two collieries which are intended to win the whole.

Having definitely fixed the site of a colliery, the next important consideration is the fixing upon the sites of the two shafts, and their relative position to and distance from each other.

Assuming that there is no doubt that the seam or seams of coal to which it is intended to sink exist beneath the royalty, the following permanent plant and buildings may be erected for use during sinking:—Permanent chimney, three to five permanent boilers, upcast engines, engine-house and headgear, workshops, electric-lighting plant and engine-house. A portion of the sidings.

The size of the shafts depends upon the following conditions:—The quantity of coal to be raised daily; the size of cages; the arrangement of conductors; the quantity of air that will ultimately be required for ventilation; the number and sizes of pipe-lines which will have to be put in for steam, compressed air, electric cables, and for pumping, if any should be required.

I will now assume that the site of the colliery has been chosen, and the position of the shafts and the distance between them fixed upon.

I will also assume that, from a consideration of the reasons given, it is decided to sink two shafts, 18 feet diameter finished, and that they will have to be sunk to a depth of 500 yards.

The whole of the surface buildings, the centres of the shafts, and the position and levels of the sidings, should be carefully and accurately pegged out.

The strata to be sunk through may be all coal measures, magnesian limestone and coal measures, or the new red sandstone, magnesian limestone and coal measures.

The pit tops must be thrown out until a good foundation of rock, shale, or stone-bind is reached, suitable for a bricking curb. It is a wise plan to put in this first length of brickwork, which may be 3, 6, 9, or 12 feet deep, according to the nature of the ground; 14 inches thick; and large enough in diameter to allow of 9in. brickwork, 18ft. diameter, to be built inside it afterwards, or to allow of the tubbing, if any is required, to come up to the surface.

It should therefore be at least 19 feet 8 inches diameter. The foundations of the headgear pillars should be got out at the same time, so that these and the first length of shaft-walling may be built together. This foundation having been reached, do not waste time and money by attempting to sink further by jack roll, windlass, or by throwing the dirt from scaffold to scaffold. Wall-up the shafts and build the headgear pillars, which, at the upcast, may be permanent, and at the downcast temporary or permanent.

The engines and headgear for sinking the downcast, which will, of course, be the main winding shaft, are generally temporary for the following reasons:—

1. The height and width of the permanent downcast head-gear depends upon the system that may be adopted for loading and unloading the cages, the number of decks in the cages, and the methods of screening, cleaning, and sorting the coal that may be required. These cannot always be planned until the nature and character of the coal to be dealt with has been proved.

2. The permanent winding engines for the downcast shaft will probably be of large size, and will take a long time to make and erect.

The temporary headgear and engines for the downcast shaft should be erected and also the permanent headgear, which may be of pitch-pine or steel, and engines for the upcast shaft.

Just a word in passing as to sinking engines; many mining engineers prefer engines for sinking geared three or four to one, to a second-motion shaft upon which the drum is fixed. My experience, however, leads me to prefer engines on the first motion, with the drum on the crank shaft, and small in diameter compared with the size of

*Résumé of lecture delivered at the University College, Nottingham.

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cylinders and length of stroke. At a large sinking under my charge we have put down at the upcast shaft a pair of 25-inch cylinder engines, with 4 feet 6 inch stroke, and 12 feet diameter drum, which have worked without the slightest trouble, and have been used for sinking the shaft from 6 feet below the surface of the ground to its present depth, about 300 yards.

If there is plenty of labour and material available, all the other permanent plant and buildings that I have indicated will be finished and ready for use by the time the steam pipes are connected to the downcast and upcast sinking engines.

We now come to the question of what make of winding ropes is most suitable for sinking.

It is acknowledged by most ropemakers that the Elliot lock-coil rope is *par excellence* the rope for sinking.

Every headgear and rope should be fitted with safety detaching hooks, and for sinking I prefer Ormerod's for several reasons.

These hooks should be got strong enough to be permanently used at the upcast shaft after sinking is finished.

In sinking much time is saved by working two or more hoppits in conjunction, so that whilst one is wound to the surface and emptied, another may be filled in the pit bottom; hence it is necessary that the winding rope should be connected with the hoppit by an attachment easily connected and disconnected. For this purpose the spring clivy is used.

PIT-TOP ARRANGEMENTS.

As all the sinkers work in the shaft, it is imperatively necessary that every precaution be taken to prevent the possibility of anything falling down the shaft. When dirt or water is being emptied, or when tools, bricks, or other materials are being put in the hoppit, the pit top must be entirely covered. For this purpose the running bridge is used, with a fence attached.

A frame 7 feet 6 inches square is formed at the pit top by balks of pitch-pine built into the brickwork. Over this the bridge runs, while all the rest of the shaft mouth is permanently covered with deals. With a running bridge of this description the pit top is always either entirely covered or securely fenced.

LIGHT.

A good light is very desirable in sinking, and of late years the electric light has been adopted with great success. A concentric cable is generally used, in which both the positive and negative wires are carried, but well insulated from each other. This allows of a good arrangement for raising and lowering the light without breaking the current and putting out the lamps. It can thus be used for examining the shaft sides from top to bottom, as well as for a stationary light in the pit bottom.

VENTILATION.

It is necessary that all sinking shafts should be well ventilated, in order to remove any gas that may be given off from the strata; for the comfort and health of the men; and for removing quickly the fumes and smoke after blasting.

For 18-feet shafts, W. I. corrugated air pipes, 2 feet diameter, are generally used, fastened together with lugs and bolts, and secured to the shaft sides.

The fan used for sinking should be a forcing fan, blowing down the air-pipes, and the air returns up the shaft. By this means a strong current of air can be blown into the pit bottom after blasting, clearing it very quickly, so that the men may get to work again without delay.

At a sinking under my charge, we have put down an 8-feet Walker fan, driven by a high-speed Bumstead and Chandler engine, coupled direct for ventilating both shafts.

It is capable of forcing 15,000 cubic feet of air per minute down the pipes, and will be used afterwards for ventilating the headings in opening the mine. When made to exhaust it will give 80,000 cubic feet of air per minute, with a 3-inch W. G.

Now in the sinking of shafts, the following conditions must be obtained:—The shafts must be truly vertical, and a true circle; the sides must be perfectly secured; and there must be no water falling down the shafts.

The shafts are kept truly vertical by means of a plumb-line, which is usually a single copper wire wound upon a small drum at the surface. The centre of the shaft is carefully fixed at the top by two notches cut into the pitch-pine balks. Into these a cross-piece of timber is dropped, having a small pulley fitted into it, whose groove is the exact centre of the shaft. The line is passed over the pulley and lowered down to the pit bottom. It is then steadied, and when motionless the chargeman carefully tries the sides all round, marking them where they are not wide enough.

(*To be continued.*)

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ANSWERS TO COMPETITION QUESTIONS

GIVEN IN No. 24, VOL. III.

WINDING.—ENGINE BRAKES.

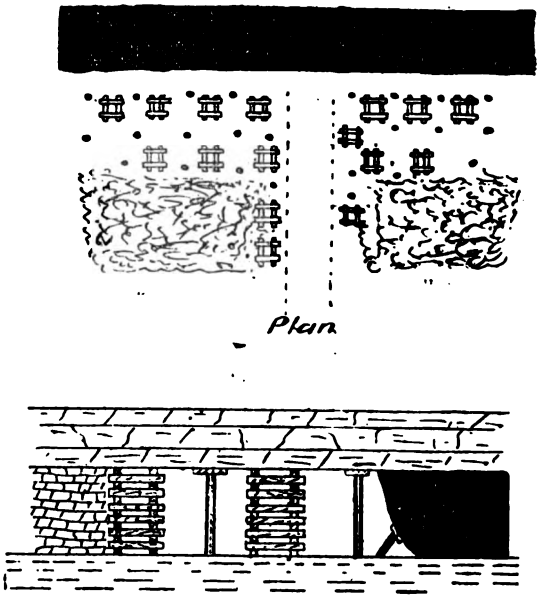
(1) State what experiments you would have made, and to what points you would specially direct attention, if required to report on the efficiency or otherwise of the brake on a pair of 24-inch winding engines, winding coal from several depths in one shaft by means of two cages.

Answer.—Before reporting on the efficiency of a winding engine brake, I should by experiment test its capability of setting up sufficient frictional resistance, to bring the cage with its load, or the engine when full steam is on, to rest, within a reasonable time, say three or five seconds. Assuming that the brake will do this, then it will be sufficiently effective to hold the cage for on-setting purposes at any intermediate seam. It does not matter what size the engines are, whether they are 24-inch cylinders or twice 24-inch, the brake must be proportionately effective. Next, I would examine the brake strap and all its connections. I would see that the strap had sufficient width, so that it would not cut rapidly into the sheave it was being applied upon. I should prefer it to reach all around the sheave, either in one continued strap or in two halves, so that the friction would be spread over a larger area, and therefore an excess of heat in any particular portion of it would be less likely to occur. The strength of the strap needs to be much in excess of that merely to offer a tensile resistance, to allow of the considerable wear. I should be careful to see that when the brakes were off that the straps were quite clear of the sheaves. Where a parallel drum is used I should prefer two straps, one on each side of the drum, and where a conical drum is employed, one strap on the centre or large circumference of the drum would be sufficient, although a foot brake for temporary use is necessary. The engineman may apply the straps by means of a lever, or worm-screw, or by steam in a cylinder, the connection being attached to the end of the piston rod.

JNO. W. NELSON.

TIMBERING.

(2) Show by sketches (plan and section) how you would timber the working face on the long wall system in a mine 500 yards deep, and where the coal is 4 feet thick, working upbrow at an inclination of 1 in 10. Give the distance you would set the props and sprags apart.



Answer.—The method of timbering and the distance apart of the props would depend to a great extent on the nature of the roof, as no particular class of roof is given, I will assume an ordinary hard shale roof. Figs. 1 and 2 are plan and section of how I would timber the face. I would use a double row of chocks or cogs along the face 3 yards apart, with props 2 yards apart, and with caps or lids 2 feet long. The props could be placed nearer where required. I would also set sprags 6 feet apart or nearer if required in compliance with C.M.R.A. Where this plan of uniform timbering is adopted we can commence in the centre of the range, and withdraw the back row of cogs and props, and thus a great saving is affected. I would support the roadways at the face with props and crown-trees, or sets of notched timber if required.

W. SLOCOMBE.

REPAIRING OF SHAFT BRICKWORK.

(3) If you had to repair the brickwork in an upcast shaft, what sort of scaffold would you use? Give sketch.

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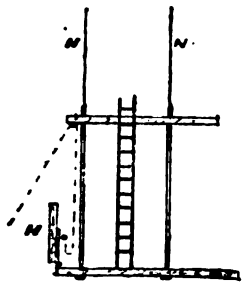
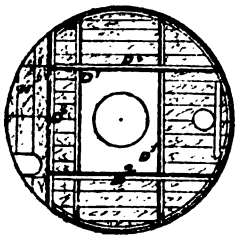
Answer.—I would strongly prefer Galloway's bricking scaffold. Its construction is as follows:—There are two platforms or stages 10 feet 6 inches apart, these are connected by four upright pieces of angle-iron, to which are attached four pieces of iron completely encircling the hole which is in the centre of the floor. The lower platform consists of four pieces of angle-iron, to which is attached the circular platform of timber; the part H on this lower platform is provided with hinges, so that it can be lifted when required in raising or lowering. The top stage or platform is rather less in diameter, but of similar form to the lower one, and access is gained from one stage to the other by means of an iron ladder. The whole arrangement weighs about 5 tons, and is suspended from the guide ropes which are 5 feet 6 inches apart from centre to centre. The advantages this patent claims over the ordinary single stage scaffold are:—(1) It is safer for the workmen, for, being formed like a cage, the top protects them from any falling material that may come from the shaft sides or from the surface. (2) The men cannot fall into the pit whilst working on the lower stage, for the hole in the centre is protected. (3) It can be raised or lowered as required, and the suspension ropes act as a guide for the hoppit, which may be used for lowering material to the workmen.





If it was thought that the holes in such a scaffold were too small to allow the ventilation to be properly maintained, the scaffold should be constructed on the grid principle.

JOHN STEPHENSON.

EDITORIAL NOTES.

It is with renewed confidence in our ability to supply a cheap journal which will fulfil the requirements of the mining community in general, that we issue this the first number of a new volume. In the course of the last volume we have affected a gradual, though nevertheless considerable change in the class of matter published; and by giving accounts—more or less abbreviated as being more suitable for our journal—of the latest improvements affected, and the newest theories and suggestions propounded on important mining subjects, we have made "Mining" as desirable for the colliery manager and mining engineer as for the student. This has been proved in a very practical and to us agreeable manner by the large number of names of colliery managers, agents, and mining engineers recently added to our list of regular subscribers.

We are being graciously assisted in our endeavour to quickly place before our readers the substance of the principal papers read during the year at the various mining institutes, by a number of the secretaries, whom we now beg to publicly thank for the courteous and painstaking manner with which they have acceded to our solicitations for their assistance.

The circulation of "Mining" at the present time is such that we doubt if it is excelled by any mining journal of this country.

* * *

Our readers are doubtless cognizant of the recent action of Bellite *v.* Roburite, in which the plaintiffs (The Lancashire Explosives Co., Ltd., manufacturers of Bellite) applied for an injunction to stop the defendants (The Roburite Explosive Co., Ltd.) from manufacturing and disposing of an explosive which it was contended was an infringement on their patent. The defence practically was that there was not sufficient modification or difference in the plaintiffs' explosive to render a patent valid. The first judgment was given in favour of the defendants, but an appeal for a second hearing in a higher court, resulted in a complete reversal and annulment of the first decision, to one in favour of the plaintiffs. Still another appeal has been lodged, but the defendants are in the meantime prohibited from selling or manufacturing any more of the explosives, and under the order of the second decision costs must be paid.

* * *

A NEW METHOD OF CLOSING UPCAST SHAFTS.—At a meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers, held at Sheffield, on Nov. 16th, Mr. A. Reid, Ffrewd Collieries, N. Wales, read a paper on the "Methods of Closing Upcast Winding Shafts." After describing the methods at present in vogue, including the chamber with separation doors and the sliding door without the adoption of chambers, Mr. Reid outlined a system used by him, in which a wrought-iron casing, fitting the cage with a little clearance all round, was built into the shaft and from the bottom of the casing, which is a little above the fan-drift, to the landing-plates was rendered air-tight. The top of the shaft flush with with the landing-plates was covered with a light wooden door, the joint was made of india-rubber and the winding rope worked through a hole in the centre. Enveloping the capping of the winding rope was a light wrought-iron pipe, 3ft. long and 6in. diam., with flanges at both ends. This was carried by a block of timber, 1ft. 3in. square and 6in. deep, bolted to the lower flange of the pipe, which rode on the lower pair of clamps of the winding rope, which were neatly tooled to prevent injury to the rope, and on the top flange of the pipe was fixed an india-rubber buffer, 15in. diam. by 6in. thick. When the top cover of the cage entered the casing the pull of the fan was taken off the top door, the winding rope in lifting the light wooden door received no shock, while the cage acted as a door closing the casing above the fan-drift. He claimed for the arrangement the maximum of convenience with a minimum of cost and no loss by leakage,

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Mr. C. E. Rhodes advocated a method of casing in the whole arrangements for banking. Mr. A. W. Bennet afterwards read a paper on "Telephonic Communication in and about Mines," and suggested, to avoid the use of an exchange in a colliery, that several insulated wires might be braided together into one cable, and that each station might have the means of communication with any other station independently of any exchange.

* * *

The Westphalian Miners' Provident Fund now contains 15 miners' preparatory schools (Bergvorsehulen) in different towns in mining districts. During the last term there were 482 young men under instruction, the full course continues for two years. A portion of this school system is a laboratory, where analyses are made of firedamp, coal, iron ore, and water; also a number of tests of coke and briquettes. One of the features of these schools intended for practical instruction is a mine heading, completely equipped and in regular operation, experiments having been made here in connection with the action of explosives on coaldust and mine gases. There is also a shaft being put down by the pupils which is provided with pumps, hoists, and all the necessary equipments for a colliery. Our mining schools in this country might take a lesson from the Germans.

* * *

On Tuesday, the 19th inst., at an ordinary meeting of the Institution of Civil Engineers a very important paper was read, entitled "The City and South London Railway; with some remarks upon Subaqueous Tunnelling by Shield and Compressed Air," by Mr. J. H. Greathead, M.I.C.E., and it dealt with the writer's experience as the designer and engineer of the line in question. The meeting which was held on the 26th was devoted to the discussion of the paper.

LITERARY REVIEWS.

GUIDE TO THE ADVANCED MINING EXAMINATIONS. By A. E. Millward, M.E. Price 4s.

Recognising the difficulty of supplying an ordinary text-book to include the syllabus of the S. & A. Dept., the author has adopted the only course open to him, namely, the answering of questions given at previous examinations. All the advanced questions given from '82 to '95 are fully and explicitly answered and illustrated. Hints to candidates and the syllabus of the S. & A. Dept. are also added. Without being a complete guide the book will effect the author's desires of putting mining students in the right groove as to the requirements of the examinations, and is, without doubt, a desirable acquisition.

HINTS ON PLAN VENTILATION. By J. Carter.

This little book will be keenly appreciated by intended candidates for the colliery managers' examinations, as in addition to the text it contains nine correctly-ventilated examination plans. Many of the hints given will be invaluable for plan ventilation, though the subject is one of which little useful information can be given. The book is divided into the following sections:—Preliminary Operations, Air Splitting, Ascensional Ventilation, Ventilation Accessories, Quantity of Air Required, Ventilated Plans Explained. The price of the book is absurdly small, viz., 6d.

CORRESPONDENCE.

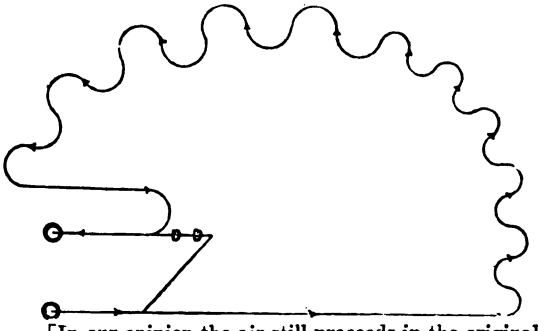
We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.
Envelopes to be marked "Correspondence."
Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.
Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

VENTILATION.

Sir,—The sketch represents a mine working pillar and stall and ventilated in one unbroken current with about 18,000 cubic feet of air per minute produced by a fan. The full course of the air round the workings is about 2,000 yards, and the short communication road between the shafts is about 200 yards long. I have had both doors open in the communication road for a short time and very little air has passed through in fact, not nearly so much as still passed round the ordinary course. I would be obliged for an explanation of this phenomenon. PUZZLED.



[In our opinion the air still proceeds in the original direction by reason of its velocity, but if the doors were left open for, say several minutes, almost all the air would pass through the doors.—ED.]

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Jno. W. Nelson, Normanby Mines, Normanby, Middlesborough.
Commended.—Wm. Slocombe.
Question 2.—Wm. Slocombe, 11, Thorne Avenue, Newbridge, Newport, Mon.
Commended.—W. Kehoe, Rishton, near Blackburn; S. Davies, Worsboro' Bridge, near Barnsley; T. Martin, Millom; J. Hardman, Haydock; M. Mowvley, Batley, Yorkshire; Wm. Mitchell, Dalharco, Patna, Ayr, N.B.; W. Dickinson, Amble, Acklington, Northumberland.
Question 3.—J. Stephenson, Wharton Street, Coundon, Bishop Auckland, Durham.
Commended.—Thos. Martin, Millom; J. Hardman, Haydock; W. Mitchell; G. H. Griffith, G. Bell, Shotton Colliery, *via* Castle Eden, Durham; W. Slocombe; J. Laverick, Eppleton Colliery, Durham.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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THE PRACTICAL SINKING AND TUBBING OF SHAFTS*

By J. P. HOUFTON.

(Continued from last issue).

THE first and paramount consideration in the carrying on of sinking operations must be the safety of the men employed, and compliance with the Coal Mines' Act and the Special Sinking Rules. Secondly, the substantial and lasting character of the work. Thirdly, economy in time and money.

I now proceed to describe the actual operations of sinking, and will deal with them in the following order:—(1) Sinking through water-bearing strata. In connection with this I shall deal with the position and shape of holes for blasting in hard and soft ground, explosives, shot-firing, timbering of sides, dealing with water, tubbing. (2) Sinking through strata free from water.

The pit bottom can rarely be broken up without blasting, unless there be a seam of coal immediately beneath it, when sometimes the water and gas in the seam will lift it. The round holes about the centre of the shaft are called "sumpers," and in ordinary sinking are put in and fired, first by double tape fuse if dry, gutta-percha covered fuse if wet, or by electricity. After these are fired, part of the men fill the dirt out; the rest drill the side holes, which are generally triangular in shape, with the base toward the centre of the shaft and the apex next to the side. These are charged and fired in the same way, and any projections left are afterwards dressed off with picks and wedges, or, if the ground is very hard, blown off with pop shots. It is very important to set all shots so that the sides may be left as solid as possible. Sometimes all the holes, both sumpers and side holes, are put in by mechanical drills, driven by compressed air and fired simultaneously. The sinking may proceed rather faster by this method, but there is a danger of shattering the sides, which may cause trouble both in putting in tubbing and afterwards. I prefer to fire all the sumpers first, and afterwards all the side holes, as the sumpers give the side holes what is known as a loose end, and the power is expended in the line of least resistance. In wet ground gelignite is more used than any other explosive. It is a safer form of dynamite, and its properties are well known. Sometimes ammonite, tonite, or other forms of the higher explosives, are used instead. All these higher explosives are unaffected by water; hence their great suitability for wet sinking, it being only necessary to keep the percussion cap and fuse protected from the water. The proper weight of explosive with which any hole should be charged depends upon the work it is expected to do, and nothing but experience can teach us how to gauge a charge. Descriptions of various methods of shot-firing were here given.

As the shafts are deepened the sides (unless in very hard rock free from slips) must be made safe until the bricking or tubbing is put in. This is usually done by lining them with timber.

For an 18-feet shaft, iron or steel rings 4 inches deep and 1 inch thick, made in convenient lengths, with fish-plates over butt joints, are fixed round the shaft. The first one is generally put on iron plugs driven into holes drilled round the sides, and the rest are hung from this by iron hangers. It is not advisable to make the distance between the rings more than 4 feet 6 inches, even in good ground, while in very bad ground they must be put considerably nearer to each other. When the ring is placed in its proper position and bolted together, boards 1½ inch by 6 or 7 inches wide are placed behind and driven tight back to the sides by wedges driven between them and the ring. The lower length of timber is made to overlap the upper from 3 to 6 inches. In good ground all the rings

*Résumé of lecture delivered at the University College, Nottingham.

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and timber are taken out as the brickwork or tubbing is put in, but in bad ground the timbering should be set back far enough to allow of the brickwork or tubbing to be placed inside of it.

We now come to the question of dealing with water during sinking. With engines and hoppits such as I have indicated, 4,000 gallons of water at 100 yards deep can be dealt with per hour without pumps. If more than this quantity is met with, pumps must be put in. There are many varieties of special pumps made for sinking, most of which can be hung in the shaft by ropes or chains, together with the steam, exhaust, and water pipes, and can be readily lowered down as the sinking proceeds. Amongst these I may mention the Denaby, Worthington, Deane, and Tangye pumps. If, however, there should be a large quantity of water, say 60,000 to 100,000 gallons per hour, it is advisable to put in the old-fashioned lift pump. Springs or feeders of water often occur in certain strata divided by strata which yield no water. Where this is the case, and the ground which yields no water is suitable for putting a wedging curb in, get it in as soon as possible, and tub the water off above it. If it is not suitable, a temporary water garland may be put in, and a tank, from which the pump may raise clean water, instead of water full of grit, from the pit bottom.

We have now to deal with the usual method of tubbing shafts so as to force the water back into the strata, and to do away with the necessity for permanent pumping with its constant cost and anxiety. This is one of the most important operations connected with the sinking of shafts, and if we are not successful in making the shaft water-tight our tubbing will be a costly failure. The tubbing is built up upon the wedging or tubbing curb. This curb is placed upon a bed cut round and in the shaft sides, which are widened out to receive it and also to make room for the wedging at the back. The greatest care is necessary in the selection of a bed for the curb, as upon this, to a great extent, depends the failure or success of the attempt to stop the water. As to thickness of tubbing required, there are many formulæ, new and old, to determine this. I will give you an example from actual practice, and you may see for yourselves how it agrees with the formula. Thicknesses of tubbing for an 18-feet shaft 120 yards deep:—30 yards of $\frac{3}{4}$ inch; 30 yards of 1 inch; 20 yards of $1\frac{1}{4}$ inch; 20 yards of $1\frac{3}{8}$ inch; 20 yards of $1\frac{5}{8}$ inch. An 18-feet shaft in ordinary ground should be walled with three rings, or 14-inch brickwork, and the bricks should be made the proper circle of the shaft. For smaller shafts wedge-shaped bricks, 8 inches or 9 inches long, and as broad as can be grasped by the hand, are often used, every course being a header course. Where the ordinary shaped bricks are used, every fourth course should be a header course. The space behind the brickwork is filled with engine ashes, or riddled soil. When the brickwork is nearly up to the wedging curb, cut the ground out carefully in small sections (quarter it, as it is termed), and thus make up the brickwork to the curb. In putting in tubbing and bricking the shaft a scaffold is required, of which two designs are shown, one with folding wings for a 14-feet shaft, the other made in halves for an 18-feet shaft. Both have holes in them, so that when necessary water may be wound through them while they are being used in the shaft. The scaffold is hung on long-link chains, secured to the tubbing curbs or brickwork. The scaffold is fastened to these chains by short chains fitted with D links and thumb-screws. When it is required to be raised the winding rope is hung to the scaffold, and it is lifted until these short chains are slack. They are then disconnected from the long-link chains, the scaffold raised to the required height, and again secured to the chains. This arrangement obviates the use of a steam capstan or winch, and has the advantage of leaving the shaft clear for winding. The scaffold is made strong enough to carry a hoppit of bricks, mortar, mortar-boards, ashes, and men, but it is advisable to have it as clear as possible when raising or lowering it. There are other methods of working the scaffold, but I need not describe them here, as this system is the best.

It will have been observed that in this lecture I have confined myself strictly to ordinary conditions of sinking and tubbing. There are methods of sinking with the hoppit running in conductors; methods of sinking and bricking simultaneously, all designed to save time; but I have not heard that sinking has been carried on more quickly by them than by the ordinary methods such as I have described. A machine has also been designed for boring shafts to any diameter by cutting a groove round the sides, leaving the core to be broken up by blasting.

Editorial communications should be addressed to Editor, "Mining," Clarence Works, Wigan.

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THE LAW RELATING TO

MINES, MINERALS, & WORKERS.

By T. F. UTTLEY, F.I.I., Manchester,
Author of "Factory and Workshop Inspection," Editor of "Labour Contracts," 4th Edition, &c., &c.

(Specially written for this Journal.)

V.—Employers and Workers as affected by the Coal Mines Regulation Act.

AN important statute is that of 1887, known as the Coal Mines Regulation Act, which applies to mines of coal, stratified ironstone, shale and clay. By a "mine" is meant every shaft in the course of being sunk, and every level and inclined plane in the course of being driven, and all the shafts, levels, planes, works, tramways, and sidings, both below ground and above ground in and adjacent to and belonging to the mine; a "shaft" is to include a pit. The term "owner" when used in any relation to any mine, means any person or body corporate who is the immediate proprietor or lessee, or occupier of any mine or part of one. An agent is the person appointed as the representative of the owner.

With regard to the employment of boys (under 16) and girls (under 16) and women (of 16 and upwards), no boy under 12 and no girl or woman can be employed below ground. A boy of 12 years and upwards when employed below ground is not to work more than 54 hours per week, nor more than 10 hours per day. As to the employment of boys, girls, and women above ground, boys and girls under 12 cannot be so employed, and in the case of those under 13 for not more than 6 days in any one week, or if employed for more than 3 days in any one week, for more than 6 hours in any one day, or in any other case for more than 10 hours in any one day. No boy or girl above 13, and no women can be employed for more than 54 hours in any one week, or more than 10 hours in any one day. Neither boys, girls, nor women must be employed in moving railway wagons. A register has to be kept of the boys, girls, and women employed. The payment of school fees may be made out of wages, the sum not exceeding 2d. per week, nor one-twelfth part of the child's wages.

There are several clauses dealing with the payment of wages, and these provide that no wages are to be paid at any public-house, beershop, licensed house, or other place of entertainment or place contiguous thereto. Where the amount of wages paid to any of the persons employed in a mine depends on the amount of mineral gotten by them, then these persons are to be paid according to the actual weight gotten by them of the mineral contracted to be gotten, and such mineral is to be truly weighed at a place as near to the pit mouth as is reasonably practicable. The owner, agent, or manager of the mine may agree with the persons employed in the mine for deductions being made in respect of stones or substances other than the mineral contracted to be gotten.

The persons employed in a mine, and paid according to the rate of the mineral gotten by them, may, at their own expense, place a checkweigher at each place appointed for the weighing of the mineral, and at each place appointed for determining the deductions. His facilities include examination and testing of the weighing machine and checking the tareing of tubs and trams where necessary. A checkweigher may give information on these matters to any workman. Where the persons employed in a mine are paid by measure or gauge, the like provisions apply as if there was weighing.

The Weights and Measures Act, 1878, applies to all weights, balances, scales, steelyards, and weighing machines used at any mine for determining the wages payable to any person employed according to the mineral gotten by him in the same way as it applies to weights used for trade, and such weights must be inspected in the usual way by the inspector of weights and measures.

Mines must have in future in communication with a seam at least two shafts or outlets by which separate means of ingress and egress are available to the persons employed in every such seam. Proper apparatus for raising and lowering persons at each shaft has to be kept. These provisions as to shafts do not apply where a new mine is merely being opened and works incidental to it are being made, nor to any proved mine exempted on conditions by an order of the Secretary of State. Where two or more parts of a mine are worked separately, the owner, agent, or manager may divide each portion into a separate mine by giving notice to the owner, &c., who, if he declines to acquiesce may have arbitration.

(To be continued.)

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EXAMINATION QUESTIONS,

WITH ANSWERS BY

J. CARTER, First-Class Certificated Manager.

Questions given in the South-Western District, Sept., 1894, for Managers' Certificates of Competency.

(The figures in parenthesis show the number of marks obtainable.)

No. 1 Subject.—ARITHMETIC.

(60 marks to qualify.)

QUESTION 1.—(*a*) Multiply $\frac{5}{6}$ of $\frac{3}{11}$ of $\frac{1}{8\frac{1}{5}}$ by $\frac{9}{11}$; (*b*) and divide $\frac{6}{11}$ by $\frac{1}{3}$ of $\frac{6}{15}$. (20)

ANSWER.—

(*a*) $\frac{5}{6} \times \frac{3}{11} \times \frac{1}{8\frac{1}{5}} \times \frac{9}{11} = \frac{9}{1694}$

(*b*) $\frac{1}{3} \times \frac{6}{15} \div \frac{6}{11} = \frac{2}{15} \times \frac{11}{6} = \frac{22}{90}$

QUESTION 2.—By drawing 453·75 gallons of water from a square tank the surface of the water falls $\frac{6}{10}$ inch. What is the inside measurement of one side of the tank? (20)

ANSWER.—One gallon = 277·274 cu. ins.

$\therefore$ 453·74 × 277·274 = 125813·0795 cu. inches in the number of gallons drawn.

These numbers of cu. inches are only $\frac{6}{10}$ths of an inch deep when in the tank, therefore the *surface area* of the tank = 125813·0795 $\div \frac{6}{10}$ = 209688·4506 sq. inches.

As the tank is square the length of one side squared will give the area, consequently the length of one side is $\sqrt{\text{area}}$.

$\sqrt{209688{\cdot}4506}$ = 457·91 ins. length of side.

QUESTION 3.—According to a colliery cost-sheet coal is delivered at the pit bank at a cost of 5/0·77d. per ton. What would be the respective costs at (*a*) an advance of $13\frac{1}{4}$ per cent. (*b*) a reduction of $6\frac{3}{4}$ per cent.? (10)

ANSWER. 5/0·77d. = 60·77d.

(*a*) $\frac{60{\cdot}77 \times 13{\cdot}25}{100}$ = 8·052 + 60·77 = 68·822d.

The cost per ton if the advance was given.

(*b*) $\frac{60{\cdot}77 \times 6{\cdot}75}{100}$ = 4·10 amount of reduction.

60·77 — 4·10 = 56·67

The cost per ton if reduction had taken place.

QUESTION 4.—If the average cost of sinking a shaft to a depth of 540 yards will amount to £18 per yard, and 23 per cent. of the strata sunk through will cost 45 per cent. more than the average cost. What will be the average cost per yard for sinking the remaining 77 per cent.? (20)

ANSWER.—Here the student must in the first place find how many yards 23 per cent. is of the total depth, and then find what is the cost per yard for such a portion at 45 per cent. above the original sum.

$\frac{540 \times 23}{100}$ = 124·2 yds. which cost 45% more.

$\frac{18 \times 45}{100}$ = 8·1 + 18 = £26·1 per yard for the 23% of depth.

The total cost = 540 × 18 = £9720

Cost of 23% = 124·2 × 26·1 = £3241·62

Total cost of remaining 77% = £6478·38

77% of depth = 540 — 124·2 = 415·8 yards

or $\frac{77 \times 540}{100}$ = 415·8 yds.

The cost per yard for sinking the remaining 77% would = $\frac{6478{\cdot}38}{415{\cdot}8}$ = £15·5805 per yd.

An abbreviated method of working this question which will be understood by the more advanced students is as follows:—

$\frac{18 \times 45}{100}$ = £8·1 amount above average cost for 23%

$\frac{8{\cdot}1 \times 23}{77}$ = £2·4195 amount below average cost for 77%

£18—£2·4195 = £15·5805 cost per yd. of 77%

QUESTION 5.—The circular upcast shaft of a colliery is 20 feet diameter, and the air-current passes through it at a mean velocity of 13 feet per second, being supplied by four returns as follows:—No. 1 return has an area of 100 feet, and the mean velocity of the air-current is 10 feet per second. No. 2 return has an area of 80 feet, and the mean velocity of the air-current is 12 feet per second. The areas of Nos. 3 and 4 returns are each 70 feet. What will be the mean velocity per second of the air-currents in Nos. 3 and 4 returns respectively, assuming that the quantities of air passing through them are in the proportion of 45 to 55? (30)

ANSWER.—In order to find this we must, in the first instance, find the quantity of air passing in the upcast shaft, thus—

Area of shaft = $20^2 \times {\cdot}7854$ = 314·16 area in square feet. Quantity of air passing per min. = 314·16 × 13 × 60 = 245044·8 cu. ft.

Area of No. 1 airway is 100 sq. feet, and the velocity is 10 feet per second $\therefore$ the quantity of air passing through it = 100 × 10 × 60 = 60,000 cubic feet per minute.

Area of No. 2 airway is 80 sq. feet, and the velocity is 12 feet per second $\therefore$ the quantity of air passing through it = 80 × 12 × 60 = 57,600 cubic feet per minute.

The quantity of air passing through Nos. 3 and 4 returns = 245,044·8 — (60,000 + 57,600) = 127,444·8 cubic feet per minute.

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Now in order to find the quantity of air that will pass in each of the returns, Nos. 3 and 4, at a proportion of 45 to 55 we must proceed thus—

No. 3 $\frac{127444 \cdot 8 \times 45}{45+55} = 57350 \cdot 16$ cu. ft. per min.

Vel. per sec. $= \frac{57350 \cdot 16}{70+60} = 13 \cdot 6548$ ft. per sec.

No. 4 $\frac{127444 \cdot 8 \times 55}{45+55} = 70094 \cdot 64$ cu. ft. per min.

Vel. per sec. $= \frac{70094 \cdot 64}{70 \times 60} = 16 \cdot 6892$ ft. per sec.

Therefore, the mean velocities in the returns Nos. 3 and 4, in the proportion as stated, will be respectively 13·6548 feet per second and 16·6892 feet per second.

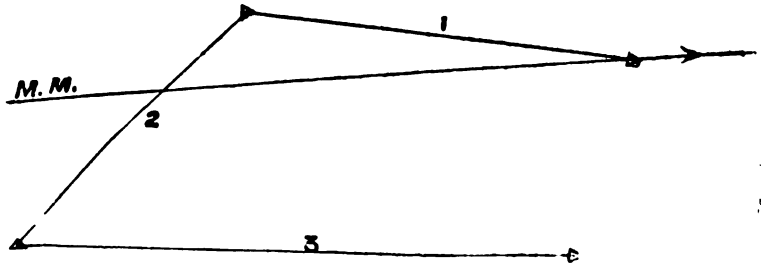
No. 2 Subject.—SURVEYING.

(60 marks to qualify.)

QUESTION 1.—Make a sketch of a vernier, and explain its use when fitted to instruments. (20)

ANSWER.—For a good description and sketch of vernier see Vol. II, page 302.

QUESTION 2.—By means of instruments provided, plot the following survey to a scale of 2 chains to an inch:—



S 11 degs. W..... 420 Links
S 40 degs. E ..... 350 ,,
N 10 degs. E ..... 600 ,, (20)

ANSWER.—See sketch.

QUESTION 3.—Describe any form of miner's dial you are acquainted with, pointing out the advantages you have experienced by the use of it underground. (10)

ANSWER.—The form of dial with which I am acquainted is the ordinary form with modern improvements. It consists of a brass compass box about 6 inches in diameter, the face of which is graduated into 360 degrees marked consecutively from 0 to 360, and also marked into four quadrants from 0 to 9, the numbering in the latter case commencing from N and S and finishing at E and W. There is a magnetic needle for reading off loose needle bearings and a vernier for reading angles. The face needle is covered by a glass plate and when not in use by another plate or cap of brass. Two spirit levels are placed *inside* the box at right angles to each other for levelling the instrument, and there is a large side arc attachment with vernier for reading vertical angles. The ordinary sights may be detached and a telescope with a long level substituted for accurate work. I prefer the graduations in the box face to be bevelled edged and the vernier, and the needle to check each other when necessary. This can be accomplished as well with inside graduations as with outside, though when a telescope is attached there is more difficulty in reading the angles. The advantages of such a dial are accuracy and compactness combined with facility of working. The side arc may be left off when not required, thus being out of the way. The levels are in the best position for quick work, and the vernier readings may be taken with the magnetic needle as a check in *one* operation. I have also found the split-ring collar clamp for connecting the dial to the legs much more accurate, and easier and quicker to work than the screw. (*To be continued.*)

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—William Mycock, New Silkworth, *via* Sunderland, County of Durham.

Commended.—Wm. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.; Alfred North, 13, Railway Terrace, Plymouth Road, Merthyr Tydvil; George A. Lodge, Bridle Street, Soothill, Batley, Yorkshire; Samuel Davies, Barrow Farm, Worsbro., near Barnsley.

Question 2.—J. Stephenson, Wharton Street, Coundon, Bishop Auckland, Durham.

Commended.—H. Hall, 15, Yardley Terrace, Ryhill, near Wakefield; Wm. Mitchell, Dalharco, Patna, Ayrshire, N.B.; William Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.

Question 3.—Samuel Davies, Barrow Farm, Worsbro., near Barnsley.

Commended.—G. A. Lodge, Bridle Street, Soothill, Batley, Yorkshire; W. Mitchell, Dalharco, Patna, Ayrshire, N.B.; H. Hall, 15, Yardley Terrace, Ryhill, nr. Wakefield; W. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.

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PLOTTING MINE SURVEYS.

Specially written for "Mining."

THE writer has no intention of dilating upon any particular method of plotting, nor to propound a new one, but to offer an explanation of a system which facilitates the ordinary method of plotting from meridians. Surveyors are now well aware that the magnetic meridian is constantly deviating, and the usual practice is to check and if necessary alter the meridian from which the surveys are plotted about once a year. The yearly deviation is only about seven minutes, so that this is quite accurate enough for ordinary purposes. It is customary to adopt two definite points on the surface of the ground from which to ascertain the magnetic meridian. These points are accurately delineated on the plan and a meridian is plotted from each periodic observation. It often happens that at extensive collieries where a number of mines are being worked simultaneously, there are as many as twenty plans of workings to be filled up, all in the one estate or "taking," and as the meridian has to be altered on each of these, say every year, they necessitate a considerable amount of labour, especially when—as is almost always the case—the workings extend on all sides of each plan, and meridian lines have to be plotted on several parts of the same plan to bring it sufficiently close to each batch of workings. Plotting the meridian on several parts of the same plan is no very difficult matter with new plans, but after a plan has been in use for a considerable number of years and cracks up, it is impossible with any degree of accuracy to parallel a line from one side of the plan to the other. These are the circumstances with which the writer had to deal; a large number of plans—in all conditions—of superposed and adjacent mines; and the plotting of the surveys was greatly facilitated by adopting a course which, though perhaps not new is not so far as the writer's knowledge extends, generally known and which may be described as follows:—

On the principal surface plan, which usually shews the whole of the "taking," a sufficient number of lines are drawn parallel to a line joining the two points from which the meridian is generally ascertained, and at a definite distance apart, say about 18 ins., to include all parts of the estate. By adopting for this distance some length corresponding to the scale of the plan, such as 500 yards, the lines will be very useful for approximating distances and areas. These lines form what may be termed "*meridian base lines*," and similar lines should be drawn on each plan of workings. This is easily accomplished by making a tracing from the original plan, shewing the lines and sufficient surface to enable the tracing to be accurately fitted on each working plan. The lines for any particular plan may be then pricked through, the lines being thus kept in the same position in each case. All that is then necessary is to place a protractor on the base line, which is situated nearest to the workings to be plotted and draw a meridian line. Assuming that a large cardboard protractor is employed for plotting—and for colliery work these are undoubtedly the best—the full advantage of the base lines may be derived. Instead of plotting a meridian on the plan for each detached portion of workings, the bearing of the base line, according to the last observation is plotted on the *protractor* and distinctly marked and dated. When plotting a survey it is not necessary to draw a meridian on the plan, but simply to place the protractor with the line shewing the bearing of the base line immediately over any one of the base lines and the protractor is in its correct position for plotting.

For example assume that the bearing of the base line as ascertained by the dial, taking an observation between the two points to which the base line is parallel, is N 10 W for any particular date. A ruler is placed on the protractor with its edge at N 10 W and at S 10 E, and a line is drawn from the graduations to the inner edge of the protractor. This line is then placed immediately over the base lines on the plan for plotting.

The advantage derived by this course will be patent; whereas in the one case the meridian every time it is changed may have to be drawn in a hundred different places (this is no exaggeration when as many as 20 plans are in use), in the other case only one line has to be drawn that being on the protractor. Not only have such a large number of meridians to be periodically plotted by the ordinary method, but the old meridian lines must be obliterated, otherwise the lines drawn one over the other will be confusing and tend to create mistakes. The lines cannot be successfully obliterated unless they are left in pencil, and when they are so drawn there is frequently a difficulty in finding them when they are required. It is not a

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considerable amount of work in the first instance to draw the meridian base lines on the plans, and when this is done the periodical change in the meridian gives little trouble, and the greater accuracy attained especially when the plans are old and broken is alone sufficient to recommend its adoption.

In a mining engineer's office where surveys of numerous different collieries have to be plotted, it would scarcely be practicable to plot the base line of each on the same protractor, and it is not probable that a large number of protractors would be employed, but one protractor might be used in this manner for say two of the most extensive collieries. When only one mine is worked in any particular district there is not much need of adopting this method. In any case there is a considerable advantage in drawing the base lines on the plan even if the bearing is not plotted on the protractor.

It might be said and not without some reason that instead of adopting a base line as above mentioned, it would be more systematic to adopt true north and south as a permanent base line, this however has its advantages and disadvantages. In the first place the true north has first to be found by some reliable and perfectly accurate method. A perfectly correct north and south line could not be calculated from the declination readings given at the observatories, even if the necessary allowances be made for the particular district, as ordinary mining instruments vary some little in the readings. Again at every observation for a magnetic meridian two calculations would be necessary to fix the true north line on the protractor with probably a slight error in the second calculation, as it would be necessary to plot the magnetic meridian, and then ascertain by means of the protractor the difference between magnetic and true meridian before the bearing could be marked on the protractor.

When adopting the method described it would be advisable to plot one meridian on each plan in the first instance, so as to avoid confusion and enable anyone who was not acquainted with the bearing of the base line to locate the workings.

All matter intended for publication should be sent with open ends, as by so doing, book-post rate only will be charged by the postal authorities. Care, however, should be taken not to affix the stamp partly on the wrapper and partly on the copy, as this renders the packet a sealed one and so liable to be charged the excess letter rates.

COLLIERY EXPLOSIONS PRODUCED BY COAL DUST.

(Reprinted from the "Colliery Guardian.")

A LECTURE was delivered by Mr. Donald M. D. Stuart, F.G.S., under this title in the theatre of the Technical Schools, Derby, on the 23rd inst., at the request of the technical education committees of the Nottinghamshire and Derbyshire county councils, in conjunction with the Midland Counties branch of the Colliery Managers' Association. The Mayor of Derby (Mr. Henry Boam, J.P.) presided, and was supported by Alderman Whittaker, Mr. A. H. Stokes (her Majesty's chief inspector of mines for the district), Messrs. W. H. Hepplewhite and R. H. Hewitt (assistant inspectors), Messrs. George Lewis, J. P. Harper, I. J. Whitty, M.Inst. C.E., C. H. Oakes, S. Alsop, G. J. Binns, J. H. W. Laverick, C. R. Hewitt, W. Simmons, G. S. Bragge, G. Spencer, C. S. S. Saunders, W. Saunders, S. B. Alsop, and a numerous audience. The Mayor, in introducing the lecturer, expressed his pleasure in presiding on the occasion, when the important question of coal dust was to be brought before them.

The lecturer expressed some diffidence in appearing before them to speak upon the question of coal dust, as he had only been working at the subject for a couple of years, whereas Mr. H. Hall and Mr. W. Galloway had been investigating the question for nearly twenty years, and many others, including Mr. W. N. Atkinson and Mr. J. B. Atkinson, for a considerable time. The coal dust committee of the Chesterfield and Derbyshire Institute of Mining Engineers had also placed before them that valuable book which contains the report of their experiments and a large amount of information on the question. The Federated Institutes had also published many contributions to the subject, and within a recent date they had had the advantage of several lectures from gentlemen who had given much time to the question. But his work had led him to conclusions differing from other investigators; and upon receiving the invitation with which the committees had honoured him, he felt under a sense of duty to place before them the grounds upon which some of his conclusions were formed. He proceeded to say that an experience of about twenty years in collieries where coal dust abounded, shot-firing was general, and gob fires sometimes prevailed, had up to the year

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1893 led him to the conclusion that coal dust was harmless in non-gaseous mines. An explosion, however, occurred about two years ago at the Camerton Collieries, which had been working for over 100 years with naked lights, and had never yielded a trace of fire-damp, in which two men were badly burnt; coked coal was deposited upon the timber, and nearly a mile of road was wrecked at intervals, and presented the appearance so often seen after explosions in gaseous mines. After preparing minute records and plans of this explosion, it still remained a mystery in his mind, as a simple calculation showed that the quantity of heat generated in the charge of explosive that was fired was utterly inadequate to cause the effects observed; and it was only after many months of reflection and some experiments with coal gas, that the difficulties were removed, and he found that, after coal dust yielded it up its gases under the action of heat from an explosive, chemical actions were initiated that provided a solution of the observed phenomena. Upon this basis of fact the conclusion became irresistible that a disastrous explosion, similar to what occurs in gaseous mines, had been produced by coal dust alone; and there remained no shadow of doubt in his mind that coal dust was an explosive agent. Another explosion occurred at the Timsbury Collieries in February last, which were also non-gaseous mines, which he found upon his investigations presented phenomena identical with what he had observed in the Camerton Collieries, and confirmed the conclusions at which he had arrived. He then turned his attention to explosions in gaseous mines, and found that the phenomena in these explosions corresponded with that observed in non-gaseous mines. He therefore selected four explosions (two in gaseous and two in non-gaseous mines) for the purpose of his lecture, and with the limited time at disposal, he confined his remarks to one phase of explosions, which embodied the evidence of fact essential to the investigation of the subject, and which was fundamental to the question. This phase was the theory he had advanced in his first book *(Coal Dust an Explosive Agent)* and developed in his second work *(The Origin and Rationale of Colliery Explosions)*, that an explosion in a mine was characterised by numerous local explosions, each disturbance being isolated, and preceded by a length of mine passage, in which the materials were practically in their normal state, or had not been subjected to violent forces. To enable the audience to follow him in unfolding this theory, he had had numerous slides prepared of views of the workings of four mines, viz., the Camerton, Timsbury, Malago Vale, and Albion Collieries, showing the places where the disasters were originated, and their subsequent development through the workings. These were thrown upon the screen by lime-light, as the lecturer travelled step by step through his evidence of fact and the inductions it yielded, and greatly aided an appreciation of the views he advanced. Each accident was traced to its origin by evidence that appeared to be demonstrative, and with equal force the development of the explosions were shown to be characterised by numerous subsidiary explosions, which left their evidence in isolated exhibitions of explosive violence. The lecturer explained the nature of the energies in the explosive disturbances and in the intervening spaces, and the extent and causes of disarrangement of materials in the latter; and with that qualification he remarked, "That the fields of disaster in the Camerton and Timsbury Collieries exhibited the effects of numerous distinct and violent disturbances, in which doors were shattered to fragments, ironwork broken and distorted, trams broken and crumpled and their contents scattered abroad, rails torn from their sleepers, timber fractured and knocked down, arches demolished, stone roof ripped in thicknesses up to 3½ feet, and men mutilated; each disturbance being preceded by lengths of mine passage, in which the trams were uninjured and their contents undisturbed, the rails were unmoved, the timber unbroken and undisturbed, the arches were undamaged, the roof was in its natural state, and the men were not mutilated. The energies in the disturbances, and the energies in the intervening spaces therefore exhibited distinct modes of action. The lecturer dealt with the Malago Vale and Albion Colliery accidents in the same manner, showing by his plans the conditions of the workings at their origin, and their development, and advanced striking facts of observation which appear to place his theory beyond question, inasmuch as the plans exhibited isolated scenes of destruction at widely distant points, which could not have had any mechanical relation with each other. In demonstrating that the initial gaseous explosion in a mine is preceded by a length of road in which no violent energies were present, he gave an interesting illustration of the Malago Vale Colliery. The accident that occurred here in 1891 was

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primarily due to ignition of firedamp, which was absolutely proved. The man who ignited the gas was instantaneously burnt to death, his companion 30 yards away was burnt, but was alive when the rescue party reached him several hours after the disaster. The lecturer then remarked that the explosive ignition of firedamp in adequate admixture with air produced a pressure of 210 lbs. per square inch, inch, therefore if the firedamp had explosively ignited, the man at whose light it occurred would have been shattered, the man 30 yards away mutilated, the timber broken and the workings wrecked. But, he added, the first man was not shattered, the second man was not mutilated, they had suffered no injury nor disfigurement beyond the burns: the timber was not broken, and the workings were not wrecked, therefore the gas not exploded; and, pointing to the jet of a Bunsen burner at his side, he said that the firedamp was burned as free from mechanical energy as the gas in that burning jet. Another impressive illustration was taken from the Albion Colliery accident, which occurred in the Upper Four-feet seam, in which, he said, 1,600 lives had been lost by explosions during the last fifty years. The bodies of the 290 men were found scattered over the field of the workings, in passages measuring over 9,000 yards, and at widely-distant points; 275 of the men had died quiet deaths by suffocation, the remaining fifteen men who were distributed at six different, and widely-distant points in the workings, intermediate between the others, were badly mutilated. To properly convey the strength of the case, the lecturer read the records of the condition of the fifteen bodies; some had had their heads and legs and arms blown away, and some were shattered beyond recognition. These mutilations, he remarked, were obviously the effects of immediately adjacent explosions; and the bodies in the passages that preceded these loci of mutilation, and in the passages beyond them were intact, and had suffered no injury except burns. Upon these evidences, and a large body of facts of the same demonstrative character, the lecturer arrived at his conclusion, in which he said that the theory of intermittent subsidiary explosions was placed absolutely beyond question as an account of what must occur, by the evidence of fact he had advanced; and therefore the mystery of colliery explosions must disappear, for it was no longer necessary to suppose that there were sudden and incredible outbursts or accumulations of firedamp at the moment of the disasters, as the coal dust, always and everywhere present in mines, was capable of giving rise to explosion, and of producing the phenomenon of subsidiary explosions. He concluded: "We have now examined disasters in typical gaseous and non-gaseous mines, and have observed that in their inception, and in their development, they present an identical *rationale* that demands for its explanation an identical explosive agent, and as coal dust was the only agent common to both gaseous and non-gaseous mines, it must have been the common source of the gases that produced the calamities he had introduced to their attention.

At the conclusion of the lecture Mr. Stuart was complimented by the Mayor and the mining engineers present for his highly instructive lecture, and for his original research upon the subject.

ANSWERS TO COMPETITION QUESTIONS

IN No. 25, VOL. III.

THE DIFFICULTIES OF USING COMPRESSED AIR.

(1) Given a pair of hauling engines underground worked by air, compressed 500 yards away; what difficulties may you expect, and how would you guard against them?

Answer. — When air is compressed its temperature is raised; also when a volume of gas is not allowed to expand its pressure varies directly as its temperature, and in the case of compression, so far from being allowed to expand it is still further compressed so that the piston encounters both the natural resistance of the air to compression, and the resistance due to the rise of temperature. The work done in overcoming the latter resistance is entirely lost when the air is allowed to cool, and therefore every effort should be made to keep the air cool during compression. The difficulties to be met with are:—(1) Generation of heat during compression, which passes away by radiation, &c., without producing any useful effect, this loss of heat represents exactly that lost in work. (2) During compression the temperature of the air being increased, its bulk is therefore greater than it should be at that pressure with the original temperature, so that the work of compression is performed on a larger bulk of air than work is obtained from. (3) Inability to get much expansion out of the compressed air at the motor. The compressed air on arriving at the motor at

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the point in which it is to be utilised, is, at or near the temperature of the atmosphere, and as a rule always holds some moisture in suspension. On expanding in the cylinder of the motor its temperature will fall to such an extent that the moisture will freeze, and ice is formed in the exhaust passage of the engine. To overcome the causes of 1 and 2 would be to adopt stage compressors with intermediate cooling, such as the West two-stage compressor. The air would be compressed to 35lbs. in the low-pressure cylinder, then passed through the intermediate cooler to the high-pressure cylinder for further compression. With regard to cause 3, we cannot afford to use the air without expansion, hence some means must be adopted to use the air expansively without being encountered with the freezing difficulty. The best means to adopt to diminish the loss from this cause is to provide air receivers of a large size both near the air compressor and the engines underground where the air is used. These together with air mains of ample dimensions would give sufficient time to deposit any moisture held in suspension, and with large and straight exhaust passages no trouble need be experienced from ice, because if there is no water it is not likely there will be ice.

WM. MYCOCK.

THE PROTECTION OF PUMPS AGAINST ACID WATER.

(2) In consequence of the stoppage of an adjoining colliery, you have to deal with an additional flow of water which passes through a considerable length of the goaf of a mine in which a large quantity of iron pyrites exists, what precautions would you take in preparing for and dealing with such water?

Answer.—Pyrites or sulphide of iron—FeS_2 is composed of about fifty-three parts sulphur to forty-seven iron. It is a pale, sometimes bright yellow mineral. There are two forms of pyrites, viz.:—Pyrites proper and the rhombic variety, called marcasite, the latter being a little paler in colour and in specific gravity. Water when it comes in contact with this sulphide of iron or iron pyrites, takes up the sulphur into solution, and thus forms sulphuric acid; the sulphur is also obtained from the slow combustion of iron pyrite; copper pyrites likewise contain sulphur. The pumps through which this water passes soon corrode if some means are not taken to prevent it. Many plans have been tried, such as steeping the pipes at a red heat in coal tar, thus the pores of the metal are filled, and the skin of the metal covered with a film of graphite (a form of carbon), but the valves and valve seats and other important parts are better made of gun-metal, and the pumps lined with thin staves of oak or some other hard wood. The water may be conveyed out-bye through sanitary pipes, they are easily handled and laid, and are also cheaper than metal pipes. At Killingworth, the acid water (or water containing sulphide of iron) was neutralised by a mixture of water and lime from the magnesian limestone.

Sulphuric acid + magnesian limestone = sulphate of lime and magnesia + carbonic acid + Water $H_2SO_4 + (MgCa)\,CO_3 = (MgCa)\,SO_4 + CO_2 + H_2O$.

JOHN STEPHENSON.

VENTILATING A SINKING SHAFT.

(3) In sinking a shaft, which has to pass through several seams of coal, state how you would ventilate it, and what precautions you would take?

Answer.—For the ventilation of a sinking shaft the best plan to adopt is to divide the pit into two compartments by a vertical division called brattice, or a line of air pipes carried down one side of the shaft. Always have plenty of pipes ready at hand, so that they may be from time to time put on when necessary, and there ought to be one small making-up length so as to allow the air to be conducted as near to the shaft bottom as possible. A small telescope-piece is sometimes used for this purpose. As regards securing the brattice or pipes, it is obvious that they must be firmly secured to the shaft sides, so that there will be no possibility of becoming disarranged or falling on the sinkers below. In this case I prefer a small fan about 3 feet diameter, driven by a small steam engine with cylinder, 6 inches diameter and 12 inches stroke; this would be sufficient for the ventilation of a single sinking shaft. The fan to be of an ordinary centrifugal type, situated a short distance from the top of the shaft. This is a very safe, easy, simple, and efficient method to adopt. The precautions I would take are as follows:—(1) When within a few fathoms of each seam I would keep two or three bore-holes in advance of the sinking operations, so as to relieve the pressure of gas from the coal. (2) See that the requirements of C.M.R.A., General Rule 1, are strictly carried out, so as to keep con-

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stantly a good pressure of air to bear on the sinking operation. (3) The use of safety lamps by the sinkers must be adopted in compliance with General Rule 8, also the use of some kind of non-flammable explosive. (4) The shaft to be examined by the master-sinker or a competent person by means of a locked safety lamp at all times before any of the sinkers descend the shaft, and a report made of every examination and signed by him in a book kept for this purpose on the surface. (5) It may be that extra lines of bricks or bricking-rings are necessary when approaching and leaving each seam; also the work of walling needs to be stronger at these points for several reasons. If these points will be maintained and constantly kept in view, the sinking operations will be be carried on successfully without any misbap.

SAMUEL DAVIES.

EDITORIAL NOTES.

In Kuhlow's German Trade Review appears an account of a deep boring in the course of being made at Sondra, in Germany, with a 7-inch bore tube, and on reaching a depth of 354 feet, by some strong and unusually active interference, the tubes were disjointed and jammed, therefore, operations had to be for some time suspended until the tubes were recovered. The cost of tubes alone conjointly with the cost of boring 354 feet was thought to be worthy of an investment for their recovery, and consequently, great efforts were made with strong grapplers to disengage the upper lengths and so reach the bore end containing the core. In this way they were successful in the face of unparalleled difficulties, even greater than those experienced in oil-holes. At this point we are brought to the interest which calls for this notice. At a depth of 354 feet the bore cut into a cleft, or open gash, in the strata, that was so small, indeed, that it made a gash in the 6-inch core, but did not cut it in two, and out of this small cleft a mighty blower of CO_2 rushed into the borehole with a pressure of from 39 to 42 atmospheres, or 588 pounds pressure on the square inch. The terribly intense cold, due to the expansion of this gas, and the deluge of water thrown with it, along with a shower of small stones, like pebbles, all conspired as allies to defeat the task of the drillers, who were doing their best to extract the broken tubes. To combat with such a task required heroism, because of the intensely cold "mineral" water the cannonade of pebbles, and the suffocating gas. The column of water, gas, and stones reached an elevation of 46 feet vertical. As we have no particulars given in the account before us of the topography of the region, we must remain in speculative uncertainty, as to the source and cause of this outburst.

* * *

The numerous explosives on the market for blasting in coal mines have a new and apparently a formidable rival in the shape of Electronite—at least so states a local (Wigan) newspaper—though personally we will require a few more particulars than are yet given before we accept the whole of this statement. The experiments which have been made were undoubtedly *ex parte*, and the public are most properly shy of accepting *in toto* the results thus published; of course such experiments are essential in the first instance for the manufacturer's own edification, and we shall probably hear something more definite later. The newspaper paragraph proceeds as follows:—The merits of this latest addition to explosives were subjected to a thorough test at the collieries of the Pearson and Knowles Coal and Iron Co., Limited, near Wigan, on November 19th, and we have received from those who conducted the experiments an authentic statement of the results. Two tests with coal dust were carried out, there being neither flame nor explosion, and the coal dust free from charring. A more serious test followed, the explosive being fired in a mixture of coal dust and gas, the latter being first infused to the extent of five per cent., and afterwards to ten per cent. In neither case was there flame or explosion All the cartridges used so far were 8oz., and were fired with No. 7 detonators, and Arley mine coal dust was used. A 6oz. cartridge fired in a heap of coal dust in the open caused no flame whatever. The firing of an 8oz. cartridge stemmed with loose coal dust, supplied by Mr. Griffiths, of the Plees Power Colliery, also had a favourable result, no flame or explosion attending the test, while other experiments of a similar type also testified to the safety of Electronite. The strength test consisted of the firing of a 25lb. projectile from a cast-steel mortar at an angle 55 degrees, with a cartridge weighing one-third of an ounce, and here again the new explosive compared very favourably with its older rivals, the projectile being thrown a distance of 147½ yards. We are informed that further experiments have since been made in the Ince and Wigan mines at these collieries, and that the results have been highly satisfactory, a very good feature of the blasting being that the coal is blown very round.

* * *

In further reference to the action of Bellite *v.* Roburite which we mentioned in last issue, we understand that the Roburite works are again open, the company having issued a circular to the effect that although prevented by an injunction from manufacturing the old Roburite, pending an appeal in the House of Lords, they are producing a new explosive of the same class, which is termed "Roburite No. 3," and which is considered to be equal to the previous explosive.

* * *

A deputation, representing the Mining Association of Great Britain, waited upon Sir M. W. Ridley at the Home Office on Wednesday, Dec. 4th, to urge upon him, in connection with the promised Employers' Liability Bill, that, with regard to mines at least, contracting out should be permitted. The deputation, for whom Mr. Tomlinson, M.P., and Mr. A. C. Briggs spoke, also urged upon the Home Secretary several amendments in legislation affecting mines. Sir M. W. Ridley, in reply, said that, as he had informed a previous deputation, the action of the Conservative party in connection with his predecessor's Bill was a sufficient indication of the intention of the Government to secure the benificent action and the continuance, under proper safeguards, of the mutual insurance societies to which reference had been made; that was to say, under proper safeguards contracting

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out should continue to be permitted. It was not necessary to say anything to convince him that it would be a disastrous thing in any legislation to seriously interfere with those societies, not only because it was natural that they should give better and more certain advantages than legislation could give, but also because—and to this he attached some importance—they promoted, and ought to promote, a good and healthy feeling between employers and employed. To the other details he promised his best attention.

* * *

A general meeting of the members of the North of England Institute of Mining and Civil Engineers will be held to-day (Saturday, Dec. 14th), in the Wood Memorial Hall, Newcastle-on-Tyne, when the following papers will be discussed:—"The Resistance of Air-currents in Mines," by T. L. Elwen; "Poisoning of Horses by Lathyrus Sativus," by F. G. Meacham; "The Whitehaven Sandstone Series," by J. D. Kendall. The following papers will be read—"A short history of the Jameson Coke Oven," by John Jameson; "Safety Explosives," by Bergassessor Winkhaus; "Shot-firing in Dusty Mines," by Bergrat H. Lohmann. A meeting of members and associates will be held immediately after the general meeting.

ERRATA.

In our report of the meeting of the executive council of the Mining Association of Great Britain, given in last issue, we gave the date as Wednesday, Nov. 25th, this should be Wednesday, Nov. 20th, 1895.

ANSWERS TO CORRESPONDENTS.

FAULTS.—If the fault gives no indications of its being up or down, it is proved as follows:—Drive a few yards through the fault into the regular strata, and if this is not recognised put boreholes up and down. See No. 26 of Vol. II.

R. M.—We consider the answer to the question sufficiently explicit, it would have perhaps been better stated thus—"Because in the *right angle* triangle A B S, A B is double of A S, then the angle A B S is 30° and the angle S A B 60°."

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before December 27th, 1895.

We invite readers to forward questions for this competition.

(1) An upcast and a downcast shaft are each 16 feet diameter, the former 190 yards and the latter 200 yards deep; the airways in the mine are four in number, the frictional resistance in each being equal to that in an airway 6 feet by 4 feet and 1000 yards long. What pressure should the water-gauge show in the upcast when 30,000 cubic feet of air is passing per minute?

(2) Give your experience in taking out coal pillars. Describe how you would protect yourself from falls of roof. Give sketches.

(3) Where is the best place for placing the water-gauge for ascertaining the ventilating pressure at a fan drift? Give your reason and illustrate your answer by a sketch showing the position of the water-gauge.

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

THEORETICAL MECHANICS.

Sir,—I beg to offer my solution to the question by T. James, with reference to the force which a body weighing one ton will exert after falling 6 feet.

The velocity which it has acquired may be found by the following formulæ:—

$V^2 = 2gs$. where v = velocity

g = gravity, and s = space passed through

$V^2 = 2 \times 32 \times 6 \quad v = \sqrt{384} \quad v = 19{\cdot}6$

The force exerted will be found by the rule:—$P = Mv$

When P = the force, M, the mass or weight of the body, and v = the velocity.

$\therefore P = 1$ ton $\times 19{\cdot}6 = 19{\cdot}6$ tons. *Ans.*

That is to say, if a weight of 1 ton that had fallen through a space of 6 feet dropped on to scale or balance it would just raise 19·6 tons in the other scale of the balance.

T. R.

The notice and price of Index for our last volume has been left out of our advertisement columns by mistake, and as a number of our readers will no doubt require them for binding we wish to state here that the price is 2½d. post free.

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Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

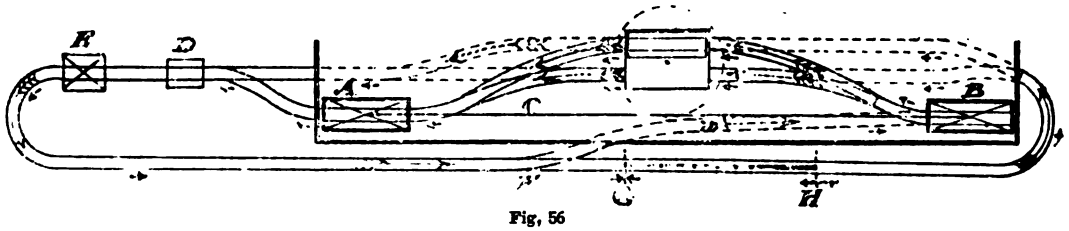
Assistant M.E.

(COMMENCED IN No. 9, VOL. III.)

BANKING ARRANGEMENTS.—Continued.

THE writer has thus far dealt more particularly with economical methods of banking on one landing, but where large quantities of coal are required daily two landings are much more efficient. As has been previously stated, if the output from the particular pit is restricted from any cause to such a quantity as can be conveniently banked on one landing—no matter whether the cages are single, double, or treble-decked—then it would be injudicious to bank on two, as two staffs of men would be required and the costs become greater. No hard and fast rule will apply to fix the number of landings for a definite tonnage, as much depends upon the time of wind, and almost the whole question rests upon the quantity raised per wind. For example, there would be no great difficulty in winding 1,000 tons per day from a depth of 400 or 600 yards and banking the same on one landing, provided the cages were, say double-decked and held three trams* in each deck, but if this output required increasing it would be undoubtedly better to bank on two landings. Restrictions in shaft space, however, might render it necessary to adopt two landings to bank a much less quantity than 1,000 tons if the cages only held one tub on each deck. With cages holding one tub on each deck the best arrangement is to have a four-decked cage with two landings, or a three-decked cage with Fowler's hydraulic apparatus. A convenient method of banking simultaneously on two landings, or "flats," is by means of gravity cages, which deal with the full and empty tubs of the upper landing.

This method is well shown in a general form by figure 56. The sketch shows the tram roads on both flats, those under the upper flat being shown dotted. The direction in which the tubs circulate is shown by the arrows placed between the lines representing the tram roads, and the direction in which the tram roads dip is shown by the small tail-less arrows. The full tubs from the upper deck of the winding-cage gravitate to the subsidiary cage A; empty tubs being in the meantime placed in the cage B, which is on the lower flat. The gravity cages, A and B, are connected by a rope C, which passes over pulleys fixed above the cages. Immediately the full tubs are placed in the cage A, it drops to the lower flat by reason of its weight and at the same time raises the cage B, containing empty tubs, from the lower to the higher flat by means of the rope C. The tubs from the cage B, now gravitate to the shaft to supply empties to the upper deck of the winding-



Fig, 56

*Trams with a capacity of 10cwt. have been taken as basis throughout these Articles.

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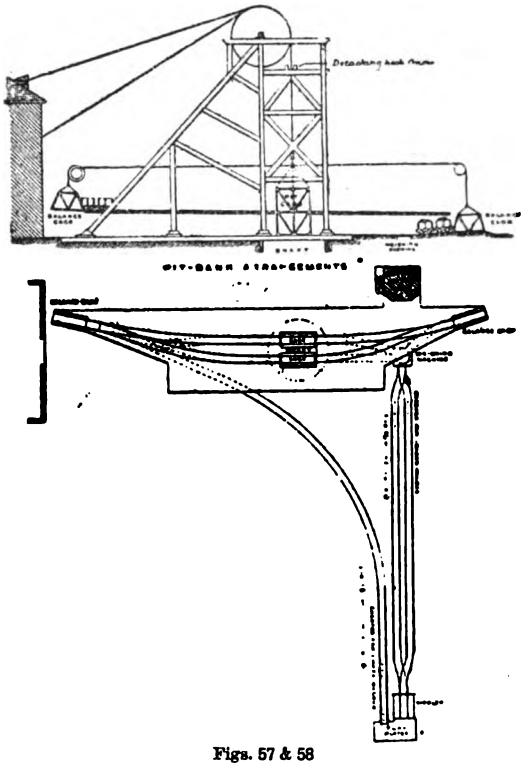
cage, while the full tubs from A pass on to the weigh-table D. During the time which it has required to execute these operations the tubs from the lower deck of the cage have gravitated along the roads shown dotted to the tippler, and will, in fact, be ahead and out of the way of the tubs from the top deck. The tubs gravitate from the weigh-table to the tippler E, and from thence round the curve to F, at which point a number of the tubs are switched off the main line to supply the gravity cage B with empties. The remaining tubs are caught singly by a creeper-chain at G, and are carried up an incline to H, where they are liberated and gravitate round the curve and supply empties to the lower deck of the cage. As will be apparent the vertical travel of the gravity cage B will be greater than that of A, as it is required to be raised to a higher level to a sufficient height for the tubs to gravitate to the shaft and from the shaft to the cage A. By the arrangement shown it is also necessary to raise B from a lower level than A descends to, as the inclination is in favour of the tubs from leaving the cage at A to the tippler, and from the tippler to B. The gravity cages are so fitted that when both are emptied B gravitates to the lower flat and raises A to the higher. It might be advantageous and, in fact, in some cases necessary to reduce the travel of the cage B by having the lowest point of the travel on a level, or approximately so, with that of the cage A. This could be satisfactorily arranged by placing the creeper-chain G H in the empty road between the tippler and the point F and allowing it to raise all the empty tubs instead of one-half, as would be the case with the arrangement illustrated. Sufficient height would thus be gained to allow for the gravitation of the tubs along all the roads.

Excellent arrangements of heapstead and gravity cages actually working are those of Harton Colliery, Durham, and of Stanton Colliery, Midlands. The gravity cages are also employed at many other collieries. The following example of this arrangement is that constructed by Mr. E. B. Wain, at a pit where it is required to deal with 1,000 tons, or 2,000 wagons daily, and which is described as follows:—* "The balance cages (figs. 57 and 58) being fixed out of the sight of the engineman, allow him a clear view of the pit top. It may be seen that the loaded wagons

* From a Paper on "Colliery Surface Works," read before the Institute of Civil Engineers, by Mr. E. B. Wain, Assoc. M.Inst.C.E.



Figs. 57 & 58

gravitate from the pit cage to the balance cage, which is connected with the cage for the empties by wire-rope $\frac{3}{4}$in. in diameter, The difference in height required to allow fall for the empty wagons to, and the loads from the cage, renders it necessary to use pulleys of different diameters; and the empty cage being on the larger pulley, power is gained to raise the other cage into position again without balance weights. The actual saving in winding by this arrangement in a pit 420 yards deep is as follows:—

	When changing decks separately.	With the double platform.
Time of winding	40 secs.	40 secs.
Changing wagons	25 ,,	10 ,,
Totals.....	65 ,,	50 ,,
Maximum runs per day of eight hours.....	443	576
Maximum weight per day (two tons per run)	886 tons	1152 tons

This shows an increase of 266 tons per day, or 30·7 per cent. on the smaller weight.

The Mines Regulation Act provides that 'where the amount of wages of any person depends on the amount of mineral gotten' it 'shall be truly weighed at a place as near to the pit mouth as is reasonably practicable.' As the large majority of miners are paid by

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weight, it is necessary to weigh each loaded wagon before it is emptied at the screens, and it is usual to place a weighing machine near to the pit shaft. This machine should, however, be placed at such a distance from the shaft as to allow standing room for a full cage-load of wagons between the machine plate and the cage. Where a large number of wagons has to be rapidly weighed, a self-recording machine should be used. There are several kinds of scales specially adapted for this class of work. The author has used two Pooley water-balance machines for several years, and has found them to be quick in action and reliable in every way. Between the weighing machine and the screens it is advisable to allow some little siding room for the loads, so that any temporary stoppage of the screens, such as that required for changing railway trucks, will not stop the work of the pit. Where this is done, some means of hauling the wagons to the screen should be provided. Fig. 58 shows an arrangement of creeper-chains and gravity roads to and from the screens, which is calculated to deal with 1,000 tons daily in eight hours. As the loads leave the weighing machines they are pushed on to a creeper chain which catches the axles and hauls them up a short incline rising 1 in 10; after reaching the summit they run clear of the chain down an easy incline of 1 in 40 to the tippler, where the coal is emptied into the screen. The tippler is so arranged that the loaded wagons push out those last emptied. When the empties leave the tippler they are twisted on the turn-plates to a second creeper-chain which hauls them up an incline of 1 in 4, from which they run back to the pit ready for filling the pit cages again. The creeper-chains run at about 60 feet a minute, and the whole time occupied in weighing, conveying to the tippler, emptying and returning the empty wagon back to the pit, a total distance of about 300 feet, is two minutes.

The cost of labour for banking 1,000 tons per day by this arrangement is as follows:—

	£	s	d
Two men pushing empty wagons into cage.	0	8	6
Two men taking loads out and weighing ..	0	8	0
Two men at the front of the tippler	0	6	8
One man behind the tippler, twisting empty wagons	0	4	0
One boy removing and sorting tallies from wagons	0	1	6
One man at the balance cage	0	3	8
One boy filling the empty balance cage....	0	1	6
Total	*1	13	10

Cost per ton, 0·4d."

* These figures show the wages paid prior to Aug., 1894, which have since been reduced 7½ per cent.

As was remarked in the discussion on Mr. Wain's paper, a switch-back arrangement with spring points (as has been previously referred to and illustrated in these articles) fitted behind the tippler as a substitute for the turntable, would still further reduce the cost by four shillings per day, as the man behind the tippler would not then be required.

(*To be continued.*)

CHESTERFIELD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS.

A GENERAL meeting of the above was held on the 7th inst., in the University College, Nottingham, when Mr. Emerson Bainbridge, M.P., presided. Mr. Wm. Hay (Burton-on-Trent) read a paper on

FENCING GATES FOR WINDING SHAFTS.

In his opinion fencing gates at landings for simultaneous loading of two-decked cages should fulfil at least the three following conditions:—(1) They should effectually fence the pit top landings when the cage is below ground. (2) When the gates are lifted by the cage they should be balanced as nearly as possible, so as to minimise the blow on the caps of the winding ropes; and (3) the bottom landing should be safely fenced against men ascending on the top deck, and thus avoid any chance of their attempting to alight upon the bottom landing. The gates described attained these conditions in a very simple manner. The leading features appeared to be that when the cage lifted the top gate the bottom gate descended at the same time through a space provided below the bottom landing. The travel of the top gates was 5¾ feet, and that of the bottom gates 3 feet. This enabled the upper gate which the cage lifted to be much lighter than if one continuous gate had to be lifted for both landings or the cage had to lift both the gates. Another advantage was that one gate almost balanced the other. In reply to inquiries, Mr. Hay stated that the weight of the gate was 50 lbs. The guide rods for the gates were greased periodically and had never stuck in any way. In order to avoid accident and prevent persons entering the top deck after the engineman had been signalled to start, a distinct signal was given by the top banksman to the lower banksman, and the latter gave an electric signal to the engineman. The cage was

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never wound sufficiently high for any danger to arise through the shaft being left unprotected.

Mr. G. C. Fowler (Nottingham) said he had an arrangement with a three-decked cage of three or four bars to each deck, sliding on rods or wire ropes which were lifted one by one by the cage as it rose, and fell back into their place as the cage descended. In addition to the loose bars there was an arrangement worked by the banksman which doubly closed and protected the top.

Mr. G. E. Coke (Chesterfield) read a paper on

A BOREHOLE BELOW THE BLACKWELL SHALE COAL AT APPERKNOWLE.

The cost of the undertaking was subscribed voluntarily by the lessors and the lessees of the coalfield, the public and tradesmen, and the workingmen of the district, to prove by means of a borehole whether there was coal in the district beneath the Black-shale Seam. The borehole had been put down 1,000 feet, but unfortunately had not proved any workable seam of coal. The President said that the borehole was stopped, not in consequence of want of funds, but because of the apparent hopelessness of finding anything that could have been worked. Mr. J. H. W. Laverick said he regarded the Kilburn coal as being the only seam of any use below the Black-shale coal and that at Riddings, this thinned out to 1 foot 10½ inches and was in consequence unworkable. It was stated that the Kilburn coal was a very good coal, but it thinned out northward. It was believed that this seam was worked at Clay Cross in George Stephenson's days, but was about the same thickness as at Riddings; it was of fair thickness at South Wingfield. There was also a seam worked at Alton, now closed, which was 4 feet thick and made good coke. When the borehole was commenced they had the Alton seam in mind as well as the Mickley, the Yorkshire, and the Whinmoor. The Alton coal he believed was a local coal, but valuable and plenty of it.

It was agreed that the discussion on the report of the committee of the North of England Institute on flameless explosives should be extended to include coal dust.

FLAMELESS EXPLOSIVES AND COAL DUST.

Mr. A. H. Stoke remarked that the German experiments were very elaborate, and he considered much better than those made in England, because the conditions were nearly those that would occur in a mine. He dissented from the comparison in the North of England report between smooth bore stemming with damp clay in a cannon, and stemming with dry material in an irregular shaped borehole in a pit. He condemned the use of gunpowder in certain districts of a mine coming under the indefinite description of "dry and dusty." Mr. J. H. W. Laverick said that if the use of gunpowder was to be prohibited at the coal face it would mean the extinction of some existing collieries. The President said that although it was possible to have explosions with dust alone, a very small percentage of gas present greatly emphasised the danger to explosion. He went out to Germany expressly to witness the most severe tests which were applied with so-called flameless explosives, and no flame was produced, and there was no doubt that high explosives possessed a degree of safety which gunpowder did not.

Discussion was resumed upon Mr. H. R. Hewitt's paper on An Underground Endless Rope at Moston Colliery, Manchester. Mr. M. H. Mills (Mansfield) said he thought they were liable to forget the advantages of compressed air and its application to small locomotives, especially where it was difficult to maintain wide roads. Such locomotives were working successfully in Durham when he was engaged there three years ago. Mr. G. Chambers (Digby Collieries) said he had some experience of a compressed air locomotive ten years ago at a colliery in Staffordshire where it proved a complete failure.

Discussion on Mr. Hay's paper on Banking, Screening, &c., was closed, and that on Mr. Stoke's paper on Photometric Values, &c., was postponed.

The bound copies of our last volume which concluded with No. 26, are now ready, and may be had from this office direct, or from Messrs. E. MARLBOROUGH & Co., 51, Old Bailey, London, at the following prices:—
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At the request of a number of our readers we have decided to issue Cases for Binding, which are now ready. Price 1s. 6d.

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NEWBATTLE COLLIERY,*

NEAR EDINBURGH.

By W. H. MUNGALL, B.Sc.

THIS colliery, belonging to The Lothian Coal Company, Limited, of which the Marquis of Lothian is Chairman and Mr. James A. Hood the General Manager, is situated on the eastern side of the Midlothian basin, a little to the south of Dalhousie station on the North British Railway, and is within nine miles of Edinburgh. The colliery is an extensive one, the area of coal to be worked being fully 15 square miles. There are four principal shafts, the Lady Victoria, Dickson, Engine, and Bryan's. The Dickson and Engine shafts are situated about quarter of a mile to the south-east of the Lady Victoria shaft, and the Bryan's shaft about one mile to the north-east of the Lady Victoria.

The seams presently being worked are:—

1 The Great Seam, which is a good steam coal and in considerable demand both at home and abroad.

2 The Diamond, a high-class household coal.

3 The Coronation, a good household coal.

4 The Splint, similar to the Great Seam.

5 The Jewel, or Parrot, which yields a high-class household coal, and also the well known "Newbattle Cannel."

The Lady Victoria Pit is at present the deepest vertical shaft in Scotland, being 276 fathoms deep, and is 20 feet in diameter. The sinking, which was completed only last year, was commenced in March, 1890, and was carried on by the aid of the Galloway scaffold, whereby the walling of the shaft with bricks was carried on simultaneously with the sinking, while the sinkers were working in perfect safety in the bottom. Considerable quantities of water were met with at various depths, but most of the feeders were successfully tubbed back by concrete walling faced with brickwork.

BOILERS.—Steam is supplied for the various engines by six steel Lancashire boilers, each 30 feet long and 8 feet diameter, for a working pressure of 100 pounds per square inch, the feed water being heated by economisers.

WINDING.—The winding engines, of 2,400 horse-power, have cylinders 40 in. diameter with 7 ft. stroke, steam jacketed, and fitted with automatic expansion gear and double-beat Cornish valves. The expansion gear is designed by Messrs. Grant, Ritchie, & Co., Kilmarnock, who were the makers of the engines. The special advantage claimed for the gear is that at the start taking the load from the bottom (about 18 tons) full steam is supplied; and after it starts and as soon as the engines attain a given speed the automatic cut-off comes into action, and thus keeps the engines at a certain speed and so gets the benefit, as far as is possible in winding engines, of the expansion of the steam.

The winding drum is 21 ft. diameter, with a brake ring at each side acted on by two steam brakes, which are under control of the engineman and are automatic in case of emergency. The automatic mechanism is shown in fig. 1, the action being as follows:—

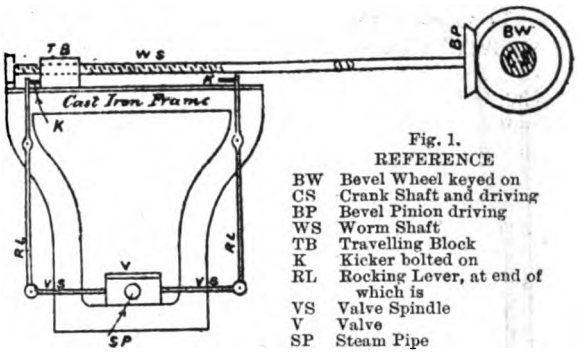

Fig. 1.

REFERENCE

BW	Bevel Wheel keyed on
CS	Crank Shaft and driving
BP	Bevel Pinion driving
WS	Worm Shaft
TB	Travelling Block
K	Kicker bolted on
RL	Rocking Lever, at end of which is
VS	Valve Spindle
V	Valve
SP	Steam Pipe

The position of TB on WS is such, that on the cage going a certain distance above the safety gates and TB still travelling on WS, it is brought into contact with K, which actuates RL and VS, causing the valve to open and the brake to be put on. The automatic brake has its cylinder independent of the ordinary steam brake, but its connecting rod is arranged to work the ordinary brake blocks.

The cages are double-decked, carrying six tubs on each deck—three on end and two abreast—each tub containing about 10 cwt. of coal. Arrangements are provided whereby both decks of the cages can be loaded or unloaded simultaneously. At the surface the arrangement consists of two floors, the upper or principal floor being on the level of the upper deck of the cage, and the lower or subsidiary floor on the level of the under deck of the cage. The tubs from the lower deck run by gravity to a point where they are caught by a creeper conveyor, and are elevated to the level and placed on the same line of rails along which the tubs from the upper deck gravitate. At the bottom of the

* From Journal of the British Society of Mining Students

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shaft the loading and unloading of the cage is facilitated by an arrangement of balanced platforms, the empty tubs from both decks of the cage being raised by a conveyor similar to that on the surface, to a point whence they run by gravity to the main sidings at the pit bottom. The winding rope is of plough steel, 2 in. diameter. The head-gear consists of a steel pulley frame 85 ft. high, with pulleys 19 ft. diameter.

Screening Plant and Surface Arrangements.—As indicated above the loaded tubs from both decks of the cage are placed on a line of rails at a point close to the shaft. From here they pass by gravity over the weigh-bridge to the tipplers of the respective screens destined to receive their contents. The tipplers are of the revolving type, driven by an Ewart's chain, and are six in number, one for each screen. A plan of the screening arrangements is given in figure 2. From the tipped tub the coal passes by an iron shoot on to a steel travelling band, 4 ft. wide, which delivers it on to a shaking screen, the essential part of which consists of a thin steel plate with circular holes, through which the small passes, while the large screened coal is delivered on to a picking band, 35 ft. long, and travelling at the rate of 36 ft. per minute, while the first or distributing band travels at half that speed, so that the coal is sparsely distributed, thus facilitating the detection and removal of foreign material and impurities. The shaking screen, which has an inclination of 1 in 5, flattened out to 1 in 7 at the delivery end, makes 120 vibrations per minute. The small coal passing through the perforations of the different shaking screens is taken by an endless conveyor to the washing plant, the large coal meantime passing into wagons.

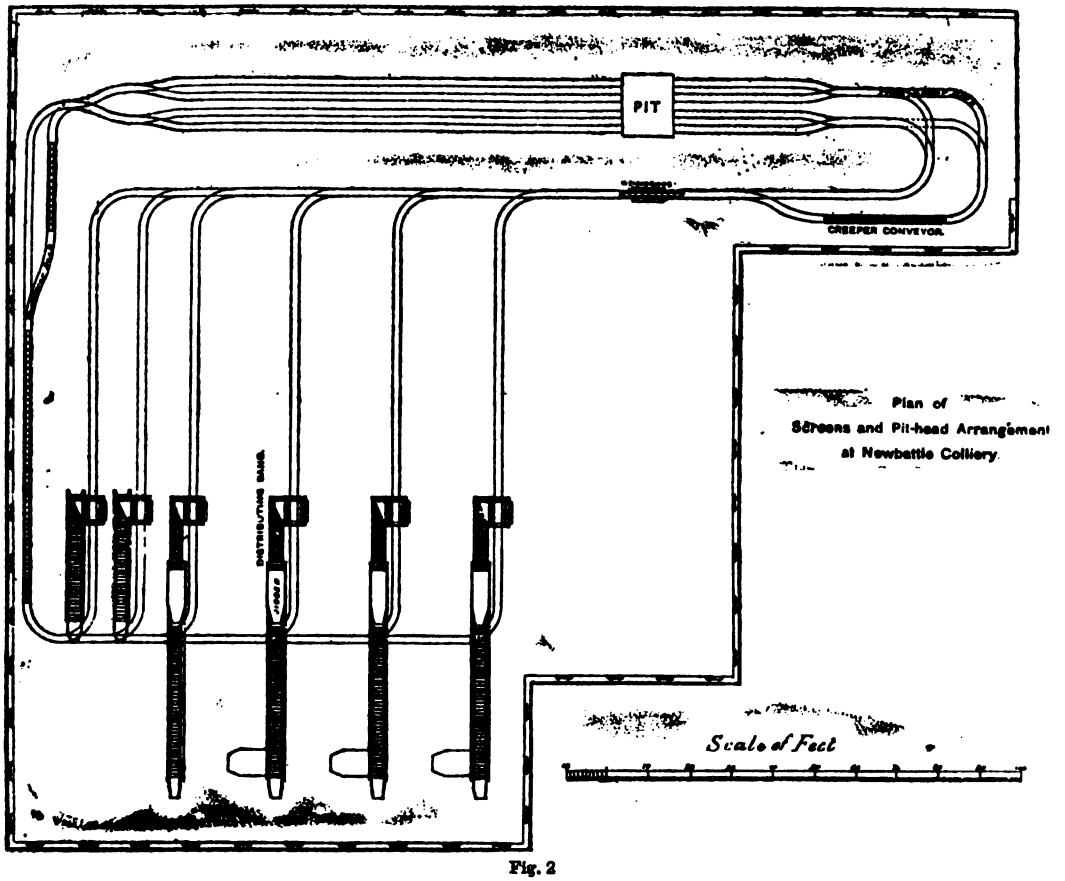

Fig. 2

The empty tub passes from the tippler by gravity to a point whence it is raised by a conveyor to an elevated point at the back of the shaft. From here the tubs run by gravity alternately to the upper and lower decks of the cage. The distribution of the empty tubs is effected automatically by the switch arrangement shown in fig. 3. The mode of

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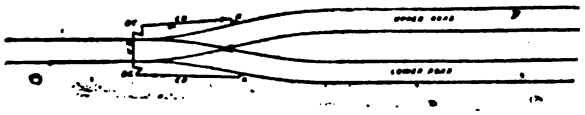

Fig. 3.

action is as follows:—The sketch shows the lower road open for traffic, and as a tub passes along it the wheel comes in contact with the kicker K which projects above the rail, and as K is depressed its motion is transmitted by the connecting rod CR and bell crank BC to the switch rod SR which actuates the switches, closing the lower road and opening the upper road for traffic. The next tub going along the upper road again reverses the switches, and so on alternately. The whole of the screening plant is driven by an engine, similar to and alongside the engines used for driving the dynamos, afterwards to be referred to.

The screening plant was designed by the Lothian Coal Company, and manufactured and erected by Messrs. Kesson & Campbell, of Hamilton, who kindly supplied the writer with the plan reproduced in fig. 2. One feature of the picking bands is that the outer end is curved downwards almost to the top of the wagons. By this arrangement the fall of the coal into the wagons is reduced.

(*To be continued.*)

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before January 10th, 1896.

We invite readers to forward questions for this competition.

(1) What is the pressure of steam per square inch in a boiler, the whole length of the safety valve lever being 32 inches, distance between the fulcrum and the valve 4 inches, diameter of valve 2½ inches, and a weight of 300⅝ lbs. placed at the end of the lever?

(2) In a winding shaft with cages running on weighted iron conductors you have to wind coal to a limited extent from a mine half-way down the shaft:—Describe and sketch the arrangements you would provide at such mine to allow the winding to be done without risk of accident.

(3) Sketch a plan showing how you would open a piece of longwall work in maiden ground, marking the direction of dip and slips, and show by arrows how you would ventilate the workings.

IMPROVED POINTSMAN'S CHECK.

IT might be said that we have reached a minimum of accidents with a maximum of traffic on our railway systems; but on analysing the various accidents reported, it appears that many of the most serious have been caused by the failure of memory on the part of signalmen, which leads one to think that any reliable "aid to memory" would still further lessen the number of disasters.

Messrs. Lord and Leason, of High Street, Manchester, have patented what they term a "Pointsman's Check for Railways," with a view to diminish the number of accidents. In all probability the Thirsk and Taunton disasters would have been averted if this "aid to memory" had been in use at the time, for in both cases the forgetfulness on the part of the signalmen caused the accident. Its value has been tested in a signal box with 90 levers, on what is known as a four-line junction. In this cabin it was applied to all the "home" signal levers both for main line and sidings. It was continually brought into play during goods shunting operations, and on one section as a protection to platelayers and traffic during rail repairs. A signalman of 25 years' experience, in explaining the present system, said that the presence of the fireman in the cabin was, in his opinion, an aid to forgetfulness rather than memory. It frequently occurred that a goods train might be detained an hour or more at the junction, and during that time many trains were received on other sections and passed, and, relying on the human reminder, the signalman does not attempt to keep the position of the train in view, If the fireman were to stand guard over the particular lever regulating the signal on the section "blocked" by his train, it is not likely an accident could occur, but such a position would render his presence a nuisance and hamper the working of the remaining levers. Then, again, the fact of other than signalmen being present in the cabin conduces to conversation and neglect of duty. In the case of platelayers, although they individually protect the section under repair, they are also very much dependant on the signalmen, and can only proceed with their work after reporting to them and receiving their sanction. In such cases it is purely a question of memory, and if some considerable time elapses before notice of

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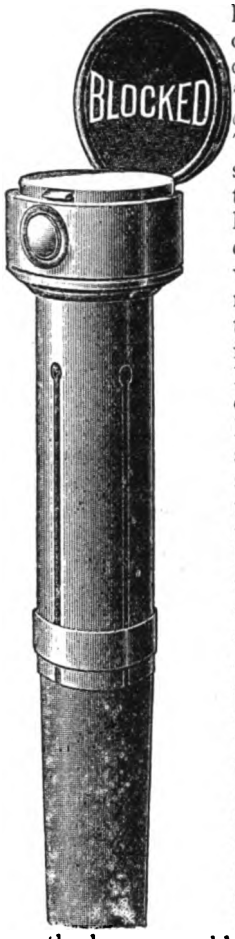
completion is reported or line signalled "clear" by the platelayers, the slightest inadvertance might bring a train on to the blocked section, and a rail being loose would derail the locomotive and perhaps cause a serious accident and loss of life. The placing of a slow or goods train on the down line, to allow an express to pass on the up is also fraught with danger in no small degree if the memory is treacherous. In all the foregoing cases we have had proof of the utility of the patent, as it seems improbable that the signalman will inadvertantly move a lever with the disc "blocked" on the handle staring him in the face. The check consists of a metal disc, having the word "blocked" painted on it on a red background. This disc is hinged to a split tube which fits over the handle of the home lever. Ordinarily, the disc is closed down, but when the signalman moves the lever over to turn an engine or train into the corresponding line, he presses a spring catch on the check, releases the disc, which springs open and remains so, as per illustration, thus warning the man that the line is blocked. He cannot possibly go to the lever again without seeing the disc, and no sane person would receive a train on that line after seeing it. That is how accidents may be prevented. A numerously attended meeting of signalmen was held in Manchester some little time ago to test the check, and they were unanimously of opinion that the adoption of the tube and disc on the levers would be of the greatest service, and while it would result in a great saving of rolling stock it would be one more safeguard to passengers and certainly a boon to signalmen. Our readers will join with us that this patent of Messrs. Lord and Leason would be simply invaluable in the signal box adjacent to every colliery siding. This invention, the utility of which has been so abundantly demonstrated, ought not be neglected. Anything which will tend to diminish the grave loss of life which does occur yearly—to say nothing of damage to property—should have the immediate attention of the Board of Trade and the leading railway companies.



ANSWERS TO COMPETITION QUESTIONS

GIVEN IN No. 26, VOL. III.

MAIN AND TAIL ROPE HAULAGE.

(1) On a level road, 1200 yards long, it is required to draw 700 tons in 9 hours, the effective pressure is 35lbs., what size of engine, trams, rope, &c., would be required with the main and tail rope system?

Answer.—Say the time actually spent in hauling, allowing stops, etc., amounts to 8 hours. Then output = 87 tons per hour. Average speed = say 10 miles per hour.

$\therefore$ Time running each way =

$$\frac{1200 \times 60}{1760 \times 10} = \frac{45}{11} = \text{say 4 mins.}$$

Allowing for stop at each end = $3\frac{1}{2}$ mins.

$\therefore$ Time for each set = $7\frac{1}{2} \times 2 = 15$ mins.

So $\frac{60}{15} = 4$ sets must be run per hour each carrying $\frac{87}{4} = \text{say 22 tons}$

Say each tub (tare 5 cwt.) carries 10 cwt., then in each set there will be

$$\frac{22 \times 20}{10} = 44 \text{ tubs}$$

Maximum strain on rope:—

Friction of full set = $44 \times (10+5) \times \frac{1}{60} = 11$ cwt.

Friction of rope (assume weight per yard = 2 lbs.) = $1200 \times 2 \times 2$ lbs. $\times \frac{1}{3\cdot8} = 171$ lbs.

Friction of rollers (assume 15 lbs. each and 10 yards apart) = $\frac{1200 \times 2}{10} = 240$ rollers

$$= \frac{240 \times 15}{28} = \frac{129}{300} = \frac{300}{112} = 2\cdot7$$

Maximum strain on rope = 13·7, say 14 cwt.

Rope:—

Say rope for 20 cwt. = 14 cwt. + 6 cwt. for wearing and emergencies. Then as safe working load = $C^2 \times \cdot45$, the rope should be

$$C^2 \times \cdot45 = 1 \text{ ton} \qquad C^2 = \frac{100}{45}$$

$$C^2 = 2\cdot22 \qquad C = 1\cdot5 \text{ inches.}$$

Rope, say 2 ins. cir., weighing $1\frac{3}{4}$ lbs. per yd.

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Maximum force to be overcome by engine :—

Friction of full set as above, 11 cwt.

Friction of ropes and rollers—

$$\frac{(2400 \times 1\frac{3}{4}) + (240 \times 15)}{28 \times 112} = 2{\cdot}48 \text{ cwt.}$$

Force = say 14 cwt. = 1568 lbs.

Speed of set = 10 miles per hour =

$$\frac{10 \times 1760 \times 3}{60} = 880 \text{ feet per min.}$$

Work to be done per min. = 1568 × 880 = 1,379,840 foot pounds.

Useful effect = say 65%, then work of steam

$$= \frac{1379840 \times 100}{65} = 2{,}122{,}830 \text{ ft. lbs. per min.}$$

Engine :—

Say two cylinders ∴ each cylinder must do 1,061,415 ft. lbs. per min.

Say piston speed 400 feet per min. and mean steam pressure = 35 lbs.

Then area of each piston $= \frac{1061415}{400 \times 35} = 75{\cdot}815$

$\therefore \quad d^2 = 75{\cdot}815 \div {\cdot}7854 = 96{\cdot}53$

$\therefore \quad d = \sqrt{96{\cdot}53} = 9{\cdot}8$ inches

Say dia. = 10 inches.

Say stroke = 2 feet.

Then revolutions of engine per minute =

$$\frac{400}{2 \times 2} = \frac{400}{4} = 100 \text{ revs. per min.}$$

Diameter of drum for 2-in. rope should be

$$\frac{2}{1} \times \frac{3}{1} = 6$$

Say dia. of drum = 6 feet. Say $18\frac{4}{5}$ cir.

Revolutions of drum per minute =

$$\frac{10 \times 1760 \times 3}{60 \times 18\frac{4}{5}} = 46\frac{7}{10} \text{ revs. per min.}$$

Gearing :—

100 : $46\frac{7}{10}$ or 2·13 to 1, say 2 to 1.

Indicated H.P. :—

$$\frac{10 \times 10 \times {\cdot}7854 \times 35 \times 2 \times 2 \times 100}{33000}$$

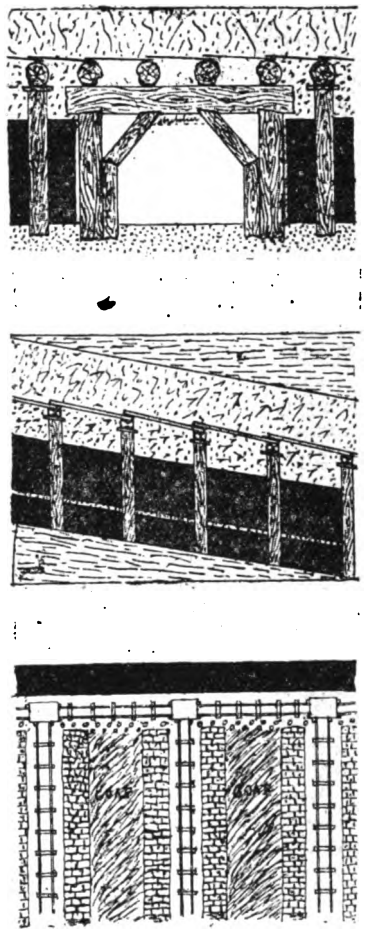
$$= 33{\cdot}3 \times 2 = 66{\cdot}6 \text{ H.P.}$$

SUMMARY OF ANSWER.—*Engine* :—Double horizontal, cylinders 10 inches dia.; stroke, 2 feet; dia. of drum, 6 feet; average strokes per minute, 100; steam pressure, 35 lbs.; geared 2 to 1; H.P., 66·6. *Trams or Tubs.*—To carry 10 cwt., tare 5 cwt.; size of tub to be 4 feet by 3 feet 1 inch by 1 foot 8 inches, made of steel, with steel wheels 12 ins. dia. *Rope* :—Patent improved steel-wire rope, 6 strands, 2 ins. in circumference and weighing about $3\frac{3}{4}$ lbs. per fathom; safe working load, 36 cwt., and breaking strain, 12 tons.

GEO. W. HEDLEY.

TIMBERING.

(2) Describe and illustrate, by plans and sections, (*a*) the method of timbering where a branch road leaves a main road at an angle of 90 degrees, (*b*) how you would timber a



Figs. 1, 2, & 3.

main engine plane with a bad roof, (*c*) the method of timbering and pillaring the face of a gateway and two adjoining gateways, for a distance of 10 yards back, in longwall working, and show what is meant by a section of timbering ?

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Answer.—(*a*) Where a branch road leaves a main road at an angle of 90 degrees I should fix at the mouth of the branch road a good strong baulk, say 12 or 15 inches square, on the top of two strong props, and, supposing the baulk to be 12 feet long, there would be, say four bar ends of the main road timbering resting on the bar of the branch road, so that I should put short props, about half the length of main props, with stretchers, as shown in sketch, for extra support.

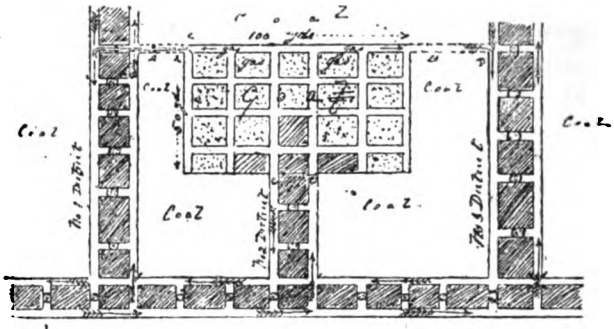
(*b*) I should timber a main engine plane, where the roof was bad, with old railway metals, with their broad sides fixed loosely on cappings on the top of strong wooden props. I should have the metals loose at the ends so that when the pressure came on it would put the timber in a position for holding the roof up. If the roof, whilst settling, happened to push any of the bar legs crooked I should set a jack-leg about a foot from the end of the bar and replace or straighten the crooked ones. If railway metals were not convenient I should use wrought-iron or steel girders in the same way as described for metals.

(*c*) The method of timbering and pillaring the face of a gateway and two adjoining gateways for a distance of 10 yards back in long-wall working is shown in fig. 3. As the coal face advances roads must be formed and kept open through the gob or goaf to communicate with the shafts. This is done by building walls of stone, termed packs or pack-walls, on either side of the road, from floor to roof. The stone for this purpose is obtained from the roof which is usually taken down in the roadways to make height for tubs to travel, or from the floor, which is in some cases taken up to make height, or from the fallen roof in the goaf. As the face advances, the gateways are advanced to keep within a few feet of it. A plan of anything is what you would see looking straight down at the object; a section is what you would see supposing the object to be cut in two. See plan of timbering (fig. 3) and section of timbering (fig. 2).

J. H. BERRY.

REMOVING ACCUMULATIONS OF GAS.

(3) How would you clear a higher side goaf, which is 50 yards up, 100 yards wide, and full of gas, assuming there is a road at each end, and that there is sufficient air available?



Answer.—Suppose that the goaf which is full of gas is situated as seen on the accompanying sketch, and it is a goave which was formed by removing the pillars of No. 2 district. The main roads on either side of this goaf are for Nos. 1 and 3 districts. It is seen that the higher side of this goaf is full of gas, which is known by its expansion when a decrease of the atmospheric pressure takes place, and it makes its appearance in the roads cc of No. 2 district. To be successful in removing this gas it will be most suitable, if possible, to take advantage of its lightness (Sp.G. ·55) and pierce the goaf at its highest point. I would drive a place at A out of No. 1 district into the high end of the goaf, at the same time having a pipe connected to the return and carried along next the roof, conveying it over the intake airway and adding more pipes as the driving advances; the pipes would also serve as a return and thereby the level would be ventilated. When driving this place I would keep boreholes at least 5 yards ahead as required by the C.M.R.A. This being the case it is most likely that I would hole into the goaf with the centre-hole first and then connect the pipes to this borehole and allow the gas to drain itself off in this manner until such time as I considered it safe to hole the place through into the goaf and afford more escape for the gas. In addition to this I would drive another place at B, out of the return airway of No. 3 district, and this would afford another road out of the goaf for the gas. If it was possible for the air to circulate through the goaf, the intake air going into No. 2 district would make its way through the goaf and into the returns of Nos. 1 and 3 districts through the two new roads.

G. DAYKIN.

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The British Society of Mining Students.

The October number of the journal of the above society is exceptionally interesting, the following being the contents:—Particulars of the Annual Meeting held on Aug. 1st. The President's (Mr. F. Brain) Address. The Secretary and Treasurer's Report. Newbattle Colliery, by Mr. W. H. Mungall, B.Sc. Notes on the History of Coal Mining in Scotland, by the same author; and Surveying, by Mr. S. Bates.

The annual meeting was held in the Hall of the Armiston Coal Co., Midlothian, N.B., and in the absence of the President (Mr. F. Brain) his address was read by the Secretary (H. F. Bulman). Mr. W. H. Mungall was elected to preside. The President in his address first dealt with the present position of the society, and stated he was pleased to say it had held its own, and financially was in a better position, but Mr. Bulman, the indefatigable Secretary, had never had greater difficulty, he believed, in getting papers contributed most of the papers having been written by Senior Members. He regretted to say it, but to be candid he felt the society was not thus filling the mission for which it ostensibly was formed. For the society to continue and flourish the younger members must rise to their responsibility and do their part. Mr. Bulman, to whom the society owes so very much, intimates his desire to resign his position. A better secretary the society never have—he is, undoubtedly, the right man in the right place. He (the President) considered that it would be little short of a calamity should Mr. Bulman persist in his intention. The President then commended several writers of papers during the past session, and referred to the Coal Mines Amendment Act and to the progress of events during the year, briefly glancing at a few of the more important.

Mr. Bulman, Secretary and Treasurer, then read his report which does not, so far as we are aware, differ much from that of the preceding year, the number of members also remaining the same, viz.:—229. Of these 5 are Free Hon., 64 Hon., 78 Sen., 76 Ordinary, 6 Life. Twenty members have contributed papers, of these twenty, only four are ordinary members. Several members urged, in the interests of the society, the re-election of Mr. Bulman, and in the absence of any other nomination Mr. Bulman agreed to retain it for the present. Mr. W. H. Mungall was unanimously elected as President for the ensuing year.

After the meeting the members were shown the works of the Armiston Colliery, and afterwards were conducted to Newbattle Colliery, which is a new colliery laid out on a liberal scale and with modern appliances. An excellent description of this colliery, by Mr. W. H. Mungall, will be found in another part of this issue. The contribution to the Journal, entitled Notes on the History of Coal Mining in Scotland, by the same author, is also very interesting; but it would require an *in extenso* reprint to do it justice.

The short paper on Surveying, by Mr. Sidney Bates, briefly describes that method of surveying in which the vernier readings are checked by the needle, and the manner of plotting a survey which was given at an Examination of the City & Guilds Institute.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Geo. W. Hedley, Medomsley Edge, Medomsley, R.S.O., Co. Durham.

Commended.—Thos. Martin, 53, Mainsgate Road, Millom; W. Slocombe, Thorne Avenue, Newbridge *via* Newport, Mon.; Abraham Ratcliffe, 61, Catlow Hall Street, Oswaldtwistle; R. M. Corless, 113, Nevill Street, Platt Bridge, near Wigan; W. Mycock, New Silksworth, *via* Sunderland, Co. Durham; G. Daykin, 24, High Guerney Villa, near Bishop Auckland; J. Hardman, 44, The Green, Haydock, Lancashire.

Question 2.—J. H. Berry, 36, Chatsworth Street, Walkden, near Bolton.

Commended.—S. Davies, Barrow Farm, Worsbro., near Barnsley; J. E. Keefe, Amble, Northumberland; G. Daykin, 24, High Guerney Villa, near Bishop Auckland; J. Stephenson, Wharton Street, Coundon, Bishop Auckland, Durham; G. W. Hedley, Medomsley Edge, Medomsley, Co. Durham.

Question 3.—G. Daykin, 24, High Guerney Villa, near Bishop Auckland.

Commended.—S. Davies, Barrow Farm, Worsbro., near Barnsley; Thos. Lawrenson, 269, New Boston, Haydock, Lancashire; Thos. Rimmer, 38, Clarence Street, Newton-le-Willows.

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EDITORIAL NOTES.

We have received a number of papers from the Transactions of the American Institute of Mining Engineers on the following subjects:—The Geological Structure of the Western Part of the Vermilion Range, Minnesota; The Nomenclature of Zinc Ores; Notes on a Southern Coal Washing Plant (discussion); The Magnetic Separation of Iron Ore; The Gold Regions of Georgia and Alabama; Southern Magnetics and Magnetic Separation; The Tin Deposits of Durango (discussion); A Section of Rich Patch Mountain at Iron Gate, Va.; Biographical Notice of Eckley B. Coxe; Chrome in the Southern Appalachian Region; Biographical Notice of Franz Posepuy; Assay of Auriferous Ores and Gravels by Amalgamation and the Blow-pipe; The Florida Pebble Phosphates; Notes on Certain Water-worn Vein Specimens; The Present Condition of Gold Mining in the Southern Appalachian States; Notes on the Magnetization and Concentration of Iron Ore; The Eastern Coal Regions of Kentucky; An Improved Protractor for Mapping Mine Surveys.

Many of the papers are of great merit, but with one or two exceptions are of little interest to the English coal mining community, as the majority of them appertain to metal mining and assaying.

* * *

On another page will be found the particulars of the annual meeting of the British Society of Mining Students and of the Contributions to the present number of the journal. We are extremely well pleased that Mr. Bulman has been prevailed upon to retain for the present the position which he has so ably filled for several years, and endorse all Mr. F. Brain's statements with reference to him, as he is and has been for some considerable time the main stay of the Society. There is one item in the Secretary's report with which we are surprised, and that is the very few ordinary members (76), and this in a Society which should represent the mining students of the country. If the importance and worth of the Society was only one-tenth of what it is at the present time the small number of members would still be a matter of surprise. The annual subscription is only 10s., and a journal is issued to each member every two months. Those who so desire may attend the annual meeting, at which one or more elaborate and modern collieries are inspected. We would advise the student readers of *Mining* to apply to Mr. H. F. Bulman, Byer Moor, Burnopfield, Newcastle-on-Tyne, for particulars of enrolment, etc.

* * *

At a meeting of the members of the Institution of Civil Engineers, on the 17th inst., the paper read was on "The Design and Testing of Centrifugal Fans" by Mr. H. Heenan, M.I.C.E., and Mr. W. Gilbert, Wh.Sc. A.M.I.C.E. The object of the experiments, recorded in this paper, was to determine the best form of fan-blade and fan-case, and the most economical diameter and speed of a fan to produce any required volume of air at a given pressure. More particulars of these experiments will be given later.

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NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

A general meeting of the above was held on the 14th inst., Mr. Douglas (president) in the chair. Mr. John Jameson submitted a paper on "The Recovery of By-products in the Manufacture of Hard Coke in the Jameson Coke Oven." A paper, by Bergassessor Winkhaus, was read on

SAFETY EXPLOSIVES.

The writer said that the experiments conducted by the Prussian Firedamp Commission, at Neunkirchen, led to this result: that high explosives, such as nitro-glycerine, gun-cotton, and blasting gelatine, if a sufficiently strong detonator be used, would detonate perfectly without igniting either coaldust or pit gas. This was deemed an all sufficient ground for the assertion that one might proceed unhesitatingly to fire shots, provided that a preliminary examination with a safety lamp showed that not more than 3 or 4 per cent. of pit gas was present in the surrounding atmosphere. If the percentage was higher ignition by electricity was recommended. Later experiments made by Mr. Lohmann showed that the harmlessness of gelatine dynamite and its associates was by no means so well assured as the first series of experiments of the Prussian Firedamp Commission had led one to believe. His conclusion was "that the use of high explosives in the presence of firedamp, and particularly at working faces, where there is dry coaldust, is in all probability infinitely more dangerous than one has hitherto been inclined to admit," and further, "that the prohibition merely of ordinary blasting powder and its congeners with a view to the avoidance of firedamp and coaldust explosions would be of so little effect as to be hardly worth mentioning." The writer proceeded to discuss the reason for the diverse results, and said it was only when Mr. Lohmann proceeded to make trials with large quantities of explosives that the ignition of pure coaldust atmospheres regularly took place with so called high explosives, and it was through Mr. Lohmann's investigations, first of all, that the formerly universally accredited opinion as to the parallel ratio of increase of blasting powder and of safety (in regard to firedamp and coaldust) of such explosives was rudely dispelled. Moreover, his experiments stimulated inventors to work for the improvement of explosives in the direction of safety, and it is from that time that we may date the first appearance of the so called flameless or safety explosives. The writer said the manufacturers of explosives were endeavouring to render their explosives less dangerous by reducing as much as possible the temperature of the gases evolved on explosion. The progress achieved justifies the hope that it will be possible to remove one great drawback attached to the safety explosives of the nitrate of ammonium group, namely, that in order to make these explosives detonate very strong detonators (which of themselves constitute a source of danger) have to be used.

M. Bergrat H. Lohmann contributed a paper on "Shot Firing in Fiery and Dusty Mines," in which he stated that the ideal perfect safety explosive is still wanted.

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Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 4. Vol. IV. January 11th, 1896.

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EXAMINATION QUESTIONS,

WITH ANSWERS BY

J. CARTER, First-Class Certificated Manager.

Questions given in the South-Western District, Sept., 1894, for Managers' Certificates of Competency.

(The figures in parenthesis show the number o marks obtainable.)

(Continued from last issue.)

No. 2 Subject.—SURVEYING.—Contd.

(60 marks to qualify.)

QUESTION 4.—Work out the quantity of coal contained in one acre of a seam of the following section :—Top coal, 2 ft. 3 in.; clod, 11 in.; Bottom coal, 2 ft. 9in.; specific gravity of coal, 1·25. (25)

ANSWER.—A cubic foot of water weighs 1000 ounces, therefore, a cubic foot of coal (whose specific gravity is 1·25) weighs (1000 × 1·25) 1250 ounces.

The weight of a cubic yard of such coal =

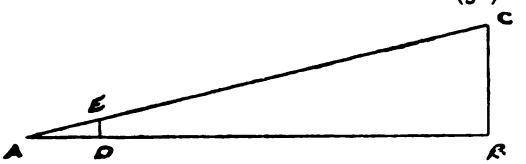
$$\frac{1250 \times 27}{16 \times 2240} = \cdot 9416 \text{ of a ton}$$

An acre of coal contains 4840 square yards and the thickness of the seam of coal is 5 feet. Find cubical contents in yards and weight in tons as follows :—

Number of cu. yds. $= 4840 \times 1\frac{2}{3} = 8066 \cdot 3333$

Weight in tons $= 8066 \cdot 3333 \times \cdot 9416 =$ 7595·259435 tons.—Ans.

QUESTION 5.—Work out the horizontal base and the vertical height of an inclined plane, 26·65 chains long, which rises 1 in 4. (30)



ANSWER.—To make this more clear I will illustrate the examples by forming a triangle, *A B C*, and this triangle again divided into another triangle, *A D E*, and proceed as follows :—

A C is the inclined plane, whose length is 26·65 chains, which rises 1 in 4 along the horizontal plane *A B*. Take the triangle *A D E*, whose two sides *A D* and *D E* equal 4 and 1 respectively, find length of *A E*.

Rule: $\sqrt{A D^2 + D E^2} = A E$

$\therefore \quad \sqrt{4^2 + 1^2} = \sqrt{17} = 4 \cdot 12311$

length in chains of *A E*.

Then if *A E* = 4·12311 chains, *B C* must =

$$\left(\frac{26 \cdot 65}{4 \cdot 12311}\right) = 6 \cdot 46356 \text{ chains}$$

And if *B C* = 6·46356 chains, *A B* must = (6·46356 × 4) = 25·8543 chains.

No. 3 Subject.

GASES AND VENTILATION.

(110 marks to qualify.)

QUESTION 1.—Name the principal gases met with in coal mines and the gases composing the atmosphere, giving the chemical symbol and specific gravity of each gas. (10)

ANSWER.—The principal gases found in coal mines are :—(1) Light carburetted hydrogen, marsh gas, or methylic hydride; symbol, CH_4; specific gravity, ·5576. (2) Carbonic acid or carbon dioxide; symbol, CO_2; specific gravity, 1·529. (3) Carbonic oxide or carbon monoxide; symbol, CO; specific gravity, ·9678. (4) Heavy carburetted hydrogen, or olefiant gas, or ethylene; symbol, C_2H_4; specific gravity, ·9784.

The principal gases composing the atmosphere are nitrogen and oxygen with a slight trace of CO_2 and other gases.

Nitrogen symbol, N; specific gravity, ·9713.
Oxygen ,, O; ,, ,, 1·1056.

QUESTION 2.—Describe the water-gauge and its utility in mining. (20)

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ANSWER.—This is an instrument of simple construction, which consists of a glass tube bent like the letter U, with both ends of the tube open. Before using, a little water is placed in the bend of the tube. A nose-piece is attached on the top of one arm which allows of it being passed through a door or stopping which separates the two currents, intake and return, thereby causing one end of the tube to come in contact with the return side of the door, and the other the intake side. Attached to the water-gauge is a sliding scale in inches and decimals of an inch, so that the difference of pressure, such as exists between the two currents, is found by the difference of water-level in the two tubes, such difference being read off by the scale attached.

Its utility in mines is to measure the amount of resistance offered to the ventilation of the mine and partly acting as a check on the state of the airways of a mine, because a contraction of an airway caused by a fall would increase the water-gauge for the same amount of ventilation. When they remain in the same state for several days and the ventilating power is not increased or decreased the water-gauge should read the same at each trial, if not, but shows an increase, then probably we should say this was due to the above cause, because increased water-gauge means increased friction from some cause or other.

QUESTION 3.—In a heading, 7 ft. 6 in. × 6 ft. 8 in., the air travels 40 yards in 12 seconds under a pressure of 2·5 in. w.g. What is the effective horse-power of the ventilation? (20)

ANSWER.—In the first place find the velocity of the air in feet per second, thus—

$$\frac{40 \times 3}{12} = 10 \text{ ft. per sec.} \times 60 = 600 \text{ ft. per min.}$$

Next we find the quantity of air in cubic feet per minute, which = quantity × area of road × velocity in feet per minute.

$\therefore$ $7{\cdot}5 \times 6\frac{2}{3} = 50$ sq. ft. area $\times$ 600 = 30000 cu. ft.

The following rule is used to find the H.P.

$$\frac{\text{Quantity} \times \text{W.G.} \times 5{\cdot}2}{33000} = \text{H. P.}$$

$$\therefore \text{ H.P.} = \frac{30000 \times 2{\cdot}5 \times 52}{33000} = 5 \text{ H.P.}$$

QUESTION 4.—A return air-current of 10000 cubic feet per minute contains explosive gas in the proportion of 1 of firedamp to 13 of air. What is the least volume of air per minute which must be added to the current to prevent its showing a "cap?" (20)

ANSWER.—We have 10000 cubic feet of air and gas in the proportion of 1 of firedamp and 13 of air. We will take 31 of air to 1 of gas as the proportion, so that it cannot be detected on the flame of a safety lamp. The quantity of air in the above volume would be

1 : 14 :: 10000 : 9285·715
14 : 1 :: 10000 : 714·285 gas in the above vol.

10000·000

The quantity of air required so that its presence cannot be detected:—

$714{\cdot}285 \times 31 = 22142{\cdot}835$ cu. ft. of air

but as there are already 9285·715 cubic feet of air in the mixture the additional quantity required would be:—

$22142{\cdot}835 - 9285{\cdot}715 = 12857{\cdot}13$

cubic feet of fresh air to dilute the gas so as not to be detected by the flame of the safety lamp.

QUESTION 5.—State the provisions of the Coal Mines Regulation Act of 1887 with regard to ventilation. (20)

ANSWER.—See General Rule I, C.M.R.A.

QUESTION 6.—What would be the percentage of change in the volume of gases in goaves owing to a fall of the barometer from 30 to 29 inches? (20)

ANSWER.—A volume of gas will contract or expand in proportion to an increase or decrease of pressure. In this instance the volume of gas will increase $3\frac{1}{3}\%$, found thus:

$$\frac{1 \times 100}{30} = 3\tfrac{1}{3}\%$$

or we may find the percentage of 29 out of 30, thus:—

$$\frac{29 \times 100}{30} = 96\tfrac{2}{3}\%$$

Therefore, we have lost in pressure $(100 - 96\frac{2}{3}) = 3\frac{1}{3}\%$, and as a consequence the volume of gas will have expanded $3\frac{1}{3}\%$ in accordance with the law of expansion and contraction of gases.

QUESTION 7.—Indicate on the accompanying plan how you would ventilate the workings there shown in a manner suitable for working a fiery seam. (30)

Plan not available.

(To be continued.)

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ANSWERS TO COMPETITION QUESTIONS

IN No. 1, VOL. IV.

COMPARISON OF LONGWALL AND PILLAR AND STALL.

(1) State definitely and briefly the conditions aud circumstances which conduce to the advantageous working of a seam by pillar and stall or longwall, and also the conditions in the latter case which determine whether the working face should be straight or stepped, or on the cleat or end?

Answer.—Both these systems have their advocates and exponents, but it is clear that neither one nor the other possess every virtue. But to my mind, the longwall system is by far the better where the circumstances are such as to favour its adoption. The conditions and circumstances are as follows:—

Pillar and Stall.—(1) Seams with very little cover, say from 80 to 50 yards, and rising or out-cropping to the surface. (2) Where the seam or seams underlie canals, rivers, large reservoirs, sea, or valuable properties or important works, etc. (3) Where the seam is of moderate thickness and contains very little dirt for packing. (4) Where the roof is very bad and the floor soft; because, in working and forming the pillars and stalls we have, as a rule, to contend with two very great evils, viz.:—"creep" and "thrust." (5) Where the seam is subjected to a large number of faults; these cutting across the royalty in various ways, and branching and re-branching: also dykes traversing the field. (6) And where the land is very valuable.

Longwall.—The advantages and conditions of adopting this system are:—(1) The chief merit is its many modifications which makes it capable of being more readily varied to suit local circumstances than pillar and stall. (2) The longwall is applicable to nearly all thicknesses of seams, and especially to seams interstratified with dirt bands of stone which may be used for packing. (3) Also in seams where the line of cleavage is very distinct, so as to be able to form the gateways out to advance across the line of cleavage, and if possible, open the faces to the rise, as when these two conditions are carried out in longwall working, the labour, etc., of winning the coal is considerably reduced owing to the gradual bending of the overlying and underlying strata. (4) It is suitable to seams with only a moderate kind of roof, such as blue shale, white post iron girdles, sandstone, or mixed clay and shale stone. (5) If the mine is of great depth, also if the royalty is not under a surface which it is not desirable to disturb. (6) A seam which yields plenty of material for packing and which breaks well or settles down gradually as the benk faces advances, thus yielding ample and sufficient refuse for stowing and packing.

Advantages claimed by longwall are:—(*a*) A better yield of round coal. (*b*) Simplicity of working. (*c*) Better and easier ventilation. (*d*) Greater economy in getting and repairing. (*e*) Less timber used and lost in the goaf. (*f*) Less friction to the air-current. (*g*) Less liability to accidents. (*h*) The gases are carried away as they are given off the coal. (*i*) The coal is always in better condition and no coal lost. (*j*) Less explosives required (if any used) or needed; the roof always fresh and better to examine. (*k*) Especially for straight longwall face, it is adapted for coal cutting machines. The last but not least of the many advantages is this: the mine is not cut up into pieces and fragments as in pillar and stall work.

I have now briefly suggested the conditions and circumstances that should guide the manager in the choice of systems which are necessary for the efficient and economical working of such a mine.

WHETHER THE FACE SHOULD BE STRAIGHT OR STEPPED? This depends very much upon the nature of the coal, thickness of seam, and the character of the roof or cover. According to experience and practice, viz.:—(1) If the roof is of blue shale, soft nature, or if the cover is subject to give off water-feeders it is advisable to work the seam on the step method. In this case the faces ought to advance towards the rise, so as to drain the working faces and to enable the goaf to break down better behind. (2) If the coal seam is excessively hard and compact, it is advisable to open such seams on the face or cleat, as the crushing action of the roof and the lifting action of the floor tend to force the coal off in large slabs, thus making it easier and less labourious to get. If the nature of the coal appears to be such that really no judgment can decide whether it will be best to work the coal on the step system or on the cleat, the best procedure would be to combine the two if possible, thus having the advantages of both, and work it half end and half face. The aim is to get as much round coal as possible, and it is on account of this that the divisional planes or cleat of the coal is so minutely studied. SAMUEL DAVIES.

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HOW THE PRESSURE IS AFFECTED BY A GOB FIRE.

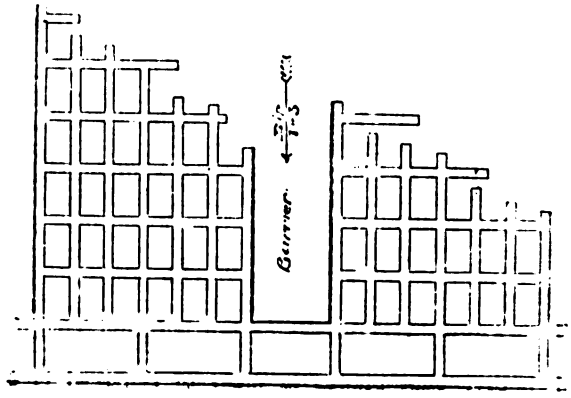
(2) A gob fire is stopped off by two stoppings in the intake and return. On which side of each wall is the greatest pressure? Give reasons for your answer.

Answer.—The greatest pressure would be on the side of the wall away from the fire both in the intake and return. My reasons are as follows:—When the fire is sealed off it will only burn as long as it can obtain oxygen, and after the oxygen in the atmosphere of the area sealed off is used up by the fire, the fire will cease to burn, and the temperature of the hot gases will be considerably lowered, thus causing a partial vacuum and the atmospheric pressure will press towards this vacuum. The difference in atmospheric pressure would be very little, as supposing the ventilating pressure between the two points on the intake and return where the stoppings are situated to be 12lbs., this would be on the square foot and would only represent $\frac{12}{144} = \frac{1}{12}$ of a lb. per square inch difference in the pressure of the atmosphere on the two stoppings, and there being a partial vacuum inside, the pressure would be outside of the wall or towards the seat of the fire in both cases. WILLIAM SLOCOMBE.

(Our correspondent has assumed that the fire is extinguished immediately it is stopped off. While the fire continues to burn, however, the greater pressure will be on the same side as the fire.—ED.)

METHOD OF WORKING A MINE.

(3) How would you work a mine 5 feet thick, with a strong metal roof and little packing material, and dip 1 in 3? Give sketch; also show how the timbering of the working places should be effected.



Answer.—Under above circumstances the dip being considerable and packing material scarce, I would adopt the bord and pillar system, working the bords and headways right away to the boundary of the taking or royalty, and work the broken backwards towards the shaft. I would leave large rectangular pillars in the first working with their longest side parallel to the line of dip, and when working backward these pillars could be cut up into smaller ones, followed up by the broken workings. I would lay out the roadways so as to have the main haulage roads on the level line and to the full dip, and the dip of the seam would enable the coals to be all jigged to the haulage roads (*i.e.*) let down by self-acting inclines. Fig. 1 shows method of work.

The timbering in taking out the pillars would be done with a double row of chocks or cogs extracting the back row to set up again as the pillar is removed.

WILLIAM SLOCOMBE.

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before January 24th, 1896.

We invite readers to forward questions for this competition.

(1) What is the largest diameter of drum which can be used to raise a load of 6 tons with a pair of engines 24 inches diameter, 4 feet stroke? Take effective working of engine as two-thirds.

(2) State briefly how you would remove an accumulation of gas, and what men and materials you would require? Give sketch if necessary.

(3) What method of working (longwall or pillar and stall) do you deem preferable for a mine subject to spontaneous combustion? Other circumstances not to be taken into consideration.

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THE LAW RELATING TO

MINES, MINERALS, & WORKERS.

By T. F. UTTLEY, F.I.I., Manchester,
Author of "Factory and Workshop Inspection," Editor of "Labour Contracts," 4th Edition, &c., &c.

(Specially written for this Journal.)

Continued from No. 2, Vol, IV.

V.—Employers and Workers as affected by the Coal Mines Regulation Act.

MINES require to be under a first-class certificated manager who is responsible for the control, management, and direction of them, and he is nominated by the owner or agent who send particulars of him to the local inspector, but the owner or agent may nominate himself to be manager. An uncertificated temporary manager may sometimes be appointed for a maximum period of two months or until he obtains his certificate. Daily personal supervision must be exercised by the manager or under-manager over the mine, the latter being nominated in writing by the owner or agent of the mine, and he must hold either a first or second-class certificate; these certificates are usually obtained by examinations. It is on the manager that the responsibilities of efficiently carrying out the statutory provisions chiefly depend. There is exemption from the necessity to employ certificated managers in mines in which less than thirty persons are employed.

The owner, agent or manager of a mine has to send to the local inspector on the 21st January in each year, a return showing the name of the mine, the situation, county, name of owner, manager, under-manager, and the number of persons usually employed below and above grouud, and whether employed on sidings and private branch railways and tramways, and in cleaning, washing and coking of coal, showing the different classes and ages of those employed, and the quantity of mineral wrought, and the number of days in each month on which the coal or ironstone has been drawn. The name of the seam, the mode of ventilation, with description, the diameter and depth of shafts, the number of splits, and the quantity of air in cubic feet per minute, and with respect to airways, the length of the splits in yards, and the sectional area in square feet, with the average total quantity of fresh air per minute in cubic feet have to be given. A plan of the mine has to be kept at the office. Notice of any explosions or accident causing loss of life or serious personal injury, must be given by the mine owner, his agent or manager, to the local inspector of mines within 24 hours. Notice has also to be given of the opening and abandonment of a shaft or seam, and likewise of any change in the name of mine or owners thereof.

Where a mine is abandoned or its working discontinued, the owner or every person interested in the minerals must cause the top of every shaft, and every side entrance from the surface, to be kept securely fenced for the prevention of accidents. Any shaft or side entrance not so fenced, which is within fifty yards of any highway, road, footpath, or place of public resort, or is in open or unenclosed land is deemed a nuisance.

The appointment of inspectors rests with the Secretary of State. Their duties comprise examination of the mines by day or night so long as they occasion no obstruction. They can enquire as to ventilation, as to safety, and as to treatment of animals. An inspector may give notice of what he considers the cause of danger, but the owner may object to comply with the notice and may require arbitration. Annual reports have to be furnished by inspectors to Parliament. The statutory provisions as to arbitration are too long to be inserted here.

With regard to coroners' inquests, these are held on those whose death may have been caused by explosion or accidents whether above or below ground, and notice has to be given to the inspector, but no person having a personal interest in the mine can serve on the jury.

The statutory general rules provide as to ventilation, stations and inspections, as to fencing entrances, as to the withdrawal of workmen in case of danger, as to safety lamps and their construction and examination, as to lamp stations, as to use of explosives below ground, as to water and boreholes, signalling and manholes for engine roads, as to manholes for other travelling roads, as to securing roof and sides, and as to timbering and winding, cover over head and chains, rope and drum, fly wheel, safety valve and gauges for boilers, as to barometer and thermometer, ambulances and stretchers, books and copies. There are also special rules established for every mine, and these must be published as directed

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by the statute, that is to say, they must be posted up in the mine and a copy furnished to the inspector.

Offences under the Act by an owner, agent or manager, entail a fine up to £20, by any other person up to £2. An offence under the Act by wilful neglect, calculated to endanger the life or limb of a miner, entails imprisonment. Proceedings should be taken within three months, and there may be an appeal to the quarter sessions.

In another article will be given an account of the Factory and Workshops Acts, 1878 to 1895; the Truck Acts; the Employers and Workman Act; the Employers and Liability Act; and other statutory provisions dealing with the relations of employers and employed in the mining industry.

THE FRICTION OF AIR IN MINES.

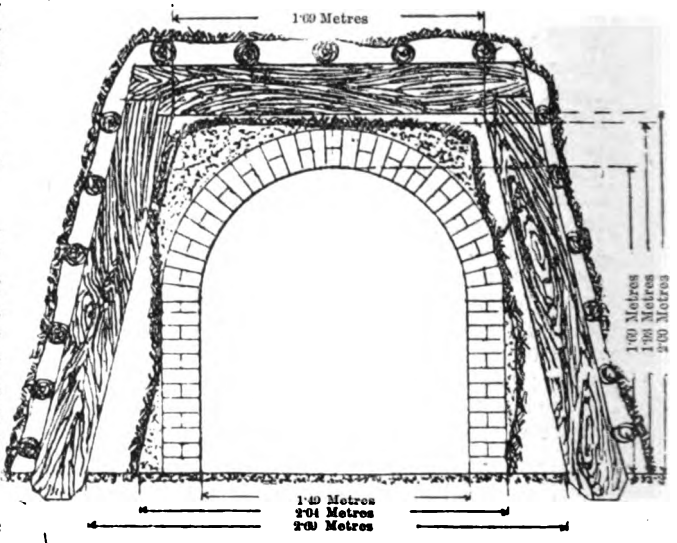
THE relation which the shape of an airway in a mine bears to the "loss of head" or what may be termed in more familiar words the water-gauge or pressure of the ventilating current, is almost universally understood; this being as regards perimeter per unit area; but the relation which the character of the lining of the road bears to the ventilating pressure, is not credited with so much importance as experiments have proved it to warrant.

In the accompanying illustration three airways are represented sectionally, all drawn to the same scale. The outer one represents a roadway supported by timber; the second one, a road cut in the rock and without any support; and the third, an arched bricked airway.

To state plainly and to give an approximate idea of the degree to which the character of the lining affects the friction of the air-current it may be said, that assuming the sectional area of the brick-lined airway to be 23 square feet, then to obtain the same discharge with a definite pressure through an airway cut in the rock the area of the latter must be about 36 square feet; and if the same is required in the third timbered airway the area (*inside the timbers*) must be about 44 square feet; the area of the excavation in the last case being considerably more. As a matter of fact these figures are not exactly those actually obtained in the experiments on which the above remarks have been based, but are sufficiently accurate to answer our purpose.

The experiments to which we refer are those reported upon by D. Murgue, the French engineer, which report was subsequently translated into the Transactions of the American Institute of Mining Engineers, by E. G. Spilsbury, from which the illustration and the following are extracts:—

"In the figure we have a very striking graphical illustration of the above results. Taking as a basis the cross-section of the rock passage of our experiment we have superimposed the contours of an arched and a timbered gangway, which for an equal discharge would absorb the same head.



Cross-Sections of Equal "Loss of Head"
For Arched, Rock, & Timbered Gangways.

EQUIVALENT AREAS.

Arched Brick-lined Gangway	2·2890 sq. mtrs.
Rock Gangway	3·5680 ,,
Timbered Gangway	4·3800 ,,

These outlines surround one another increasing from the brick-lined section to the timbered one, so as to compensate by loss of velocity for the increase in the co-efficient for the loss of head. As shown, the contour of the arched gangway leaves a space nearly all around inside the contour of the rock cut, of 0·22 metre,* showing that it is possible to line any normal rock gangway with bricks 0·22 metre thick, without in any way impairing its efficiency as an airway. The inside contour of the timbered section is much larger than that of the rock gangway, and as it is necessary to drive the passage large enough to insert the timbers it proves that

* One Metre = 39·37 ins.

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if timbering is determined upon it will be requisite to double the size of the drift if we wish to maintain the same standard loss of head."

In closing this paper we must acknowledge that our experiments have only confirmed what might have been expected. We think, however, that it is not useless to replace theories by numerical certainties. Whatever may be said it is evidently to the interest of mine operators as well as their duty when working fiery mines to increase as much as possible the intensity of the air-currents in their workings, and this will be sooner and better attained by endeavouring to diminish throughout the loss of head, rather than by hunting up more efficient ventilating machines. Besides the old and effective method of enlarging the cross-section to lessen the velocities our experiments show that there are others which should not be neglected, viz., the substitution of masonry for timber work, and even for rock cuttings; the straightening of crooked lines and the elimination of subnormal cross-sections, which will not only seriously affect the acceleration of the air-velocities but also sensibly increase the co-efficient of the loss of head.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Samuel Davies, Barrow Farm, Worsbro., near Barnsley.

Commended.—J. Stephenson, Wharton-St., Coundon, Bishop Auckland, Durham; Wm. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.; J.W. McKearn, 11, Tyne-St., Willington, Durham; John W. Nelson, Normanby Mines, Normanby, Middlesbro'; T. Watson, 3, East Hedley Hope, Tow Law; R. W. Corless, 113, Neville-St., Platt Bridge, near Wigan; M. Mowvley, Rock Terrace, Soothill Lane, Batley, Yorkshire; H. Hall. 15, Yardley Terrace, Ryhill, near Wakefield; Thos. Rimmer, 38, Clarence-St., Newton-le-Willows.

Question 2.—William Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.

Commended—J. Stephenson, Wharton-St., Coundon, Bp. Auckland, Durham; J. Buckley, 14, Florence St., Burnley; J. Hardman, The Green, Haydock, St. Helens; S. Davies, Barrow Farm, Worsbro., nr. Barnsley; G. Bell, Shotton Colliery, *via* Castle Eden, Durham; Geo. Daykin, 24, High Gurney Villa, near Bishop Auckland, Durham.

Question 3.—William Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.

Commended.—Jas. Hardman, The Green, Haydock, near St. Helens; M. Mowvley, Rock Terrace, Soothill Lane. Batley, Yorkshire; Thos. Rimmer, 38, Clarence-St., Newton-le-Willows; H. Hall, 15, Yardley Terrace, Ryhill, near Wakefield.

ANSWERS TO CORRESPONDENTS.

G. G. (Pontycymmer).—Cannot make out what you want; write again.

OBSERVER AND OTHERS.—Thanks for attracting our attention to the extract. Our journal is so widely read that even if our original matter is not duly accredited to us it is generally recognised. We would, however, desire students for their own benefit to make an attempt for themselves, or at least acknowledge the source of their information.

J. F.—(1) The requirements of the South Staffordshire District Examination are, that the candidates, either for a first or second-class certificate, must be 23 years of age and must have had 5 years' practical experience in a mine; the examination is usually held in January; for particulars apply to the Secretary, R. S. Williamson, Esq., Cannock Wood House, Hednesford. (2) Yes; we could do what you wish, but not knowing you personally we are afraid it would be of little service.

G. W. (Burnley).—Only too pleased to have been of service. Write us how you go on.

H. P. (Leeds).—Yours received. It does not alter what we wrote you previously.

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.
Envelopes to be marked "Correspondence."
Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.
Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

THE WORKING OF SEAMS IN CLOSE PROXIMITY.

Sir,—Will some reader kindly take the trouble to answer the following question:—Two seams, each 3 feet thick, fireclay under both of them, blue shale at top of each seam; sometimes 4 feet apart, at other times 12 feet apart. How would you work the seams, dipping 1 in 10? CONSTANT READER.

GEOMETRY.

Sir,—I would be obliged for an answer to the following question:—In a square field, $A\,B\,C\,D$, is a tree, situated 200 yards from one corner A, 300 yards from B, and 400 yards from C. What is the length of one side of the square? PUZZLED.

[Our correspondent has every reason to sign himself "PUZZLED," as this is a very difficult question. To incite perseverance in answering the above we will award 5/- for a correct solution, and 2/6 for the best approximate solution.—ED.]

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NEWBATTLE COLLIERY,*

NEAR EDINBURGH.

By W. H. MUNGALL, B.Sc.

(Continued from Last Issue.)

THE COAL WASHING PLANT consists of a set of three Robinson washers, the washed material being subsequently separated by a revolving screen into six different sizes to suit the requirements of the market. At the time of the visit of the Society this plant was not completed, and was consequently not seen in operation. When completed it is intended to wash 600 tons per day.

ELECTRIC PUMPING PLANT.—The installation consists generally of:—Three horizontal engines, each capable of developing 150 effective horse power, with a steam pressure of 100 lbs. per square inch. Three "Tyne" dynamos, each capable of giving an output of 60,000 Watts, at a speed of 600 revolutions per minute. Three electric motors, each of 60 horse power. Three sets of three-throw pumps, each capable of delivering 200 gallons of water per min. against a head of 650 feet.

The engines, which are fitted with Corliss valve gear, have cylinders 15½ in. diameter with 33 in. stroke, and each is provided with an injector condensor placed behind and worked by an extension of the piston rod. A main counter shaft, fitted with driving pulleys for receiving the main driving belts from the engines, runs the entire length of the engine-house. Each of the pulleys is fitted with a clutch so that they can be put in or out of gear as required, and any desired combination of engines and dynamos can be obtained.

The dynamos are of Messrs. Scott and Mountain's improved mining type, each capable of giving an output of 120 Ampères, with an E.M.F. of 500 volts when running at a speed of 600 revolutions per minute.

The main conducting cables from the dynamos to the pump motors are six in number, each having a core of 19 wires 15 B.W.G., insulated with a thick coating of bitumenised fibre and heavily armoured with iron wire.

The electric motors are similar in construction and design to the dynamos, and are each capable of developing 60 effective horse power at a speed of 600 revolutious per minute.

* From Journal of the British Society of Mining Students.

The pumps are of the vertical three-throw type, the bodies of each set being interchangeable as also are the connecting pipes. The suction and delivery valve boxes are all independent. The rams are of gun metal, 7½ in. diameter, with 12 in. stroke. Power is transmitted from the motors to the pumps by belting and helical spur wheels and pinions.

AIR COMPRESSING PLANT.—This consists of two compound condensing engines, the cylinders being, high pressure 18 in. diameter, low pressure 36 in. diameter, with a stroke of 4 ft. The air compressing cylinders are of the following sizes:—Low pressure 28 in. diameter, in which the air is compressed to 30 lbs. per square inch, after which it passes into the high pressure cylinder 17 in. diameter, where it is compressed up to 70 lbs. per sq. in.

In one of the compressors (built by Messrs. S. & H. Morton & Co., Leith) there is a special arrangement for keeping the air cylinders cool by means of double pistons, between which the water is confined and thus prevented from mixing with the air, and in the course of the stroke is brought in contact with the whole inside surface of the cylinder. At the same time cold water is circulated on the outside of the cylinders. The following particulars were kindly supplied by Messrs. Morton:—

Steam cylinders, 18 in. and 36 in. diameter; air compressors, 17 in. and 28 in. diameter by 48 in. stroke. Approximately, making 50 revolutions per minute, will consume about 9 tons of coal per day of 24 hours, and compress about 1,710 cubic feet of air at atmospheric pressure to a volume of 205, or say 90 per cent. = 184·5 cubic feet at a pressure of 110 lbs. above atmospheric pressure. Air acted upon each single stroke, 17·66 cubic feet compressed in first cylinder to 30, and in second cylinder to 120 lbs. per square inch above atmospheric pressure. Temperature of air from both compressors = 80 to 90 degrees. Water required at 50 degrees for cooling air, 9 lbs. for each single stroke of each compressor.

	per cent
Losses from clearance at cylinder ends =	4
,, ,, air being heated..... =	12
,, ,, sundry causes..... =	4
Total Loss...	20

Dickson Pit.—This shaft, situated about 500 yards from the Lady Victoria shaft, is the upcast shaft of the colliery. The ventilating current is induced by a Guibal fan,

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30 ft. diameter, and passing 100,000 cubic feet of air per minute, at a speed of 42 revolutions per minute, with a water-gauge of 2½ in.

PUMPING.—The principal object of interest at this pit is a triple expansion underground pump, raising 1,000 gallons of water per min. through a height of 900 feet. The cylinders are: high pressure, 23 in. dia.; intermediate, 33 in. dia.; low pressure, 50 in. dia., with a 3 ft. 6 in. stroke. The normal speed is 50 revolutions per minute. There are six rams, each 6 in. dia., and single acting. Steam is taken down the shaft from boilers on the surface, at a pressure of 100 lbs. The pressure in the various cylinders are: high pressure, 80 lbs.; intermediate, 28 lbs.; low pressure, 2 lbs., with 25 in. vacuum.

(Further particulars of this elaborately arranged colliery would be interesting, and we will endeavour to supply them in course of a few issues.—ED.)

THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

Assistant M.E.,

First-class Certificated Colliery Manager.

(Commenced in No. 9, Vol. III.)

BANKING ARRANGEMENTS.—Continued.

THE gravity cages which have been described for banking on two landings, are not always fixed a distance apart on each side of the pit, but are sometimes situated close together. The latter is not however the better arrangement as the use of gravity roads for the circulation of the tubs can not be laid out with the same advantage.

Another method of banking simultaneously from two decks is arranged by creeper chains alone, and is, in the writer's opinion, preferable to gravity cages for surface banking, unless the power is not conveniently available. One of the best practical illustrations of this system is that of Newbattle Colliery.* The general principles of the system are clearly shown by fig. 59. The *modus operandi* is as follows:—The full tubs from the lower deck of the cage gravitate to the point A where a creeper chain is fixed, which hauls the tubs up an incline to the upper landing. At B the tubs are liberated from the chain, and the inclination of the road now being in their favour they gravitate to the weigh table C, and on to the tippler D. In the meantime the full tubs from the upper deck of the cage have gravitated to the weigh table C and will have preceded the tubs from the lower deck. The empty tubs are discharged from the tippler and gravitate round the curve and on to the point E. Half of the number of tubs are here branched off to the road which leads to the lower deck, to which the tubs gravitate of themselves, the remaining tubs pass on to F where they are caught by a creeper chain and hauled up an incline to G, from whence they pass to supply tubs to the upper deck.

It will be observed that by raising the full tubs from the lower to the upper landing sufficient height has been attained to allow the tubs to gravitate back to the other side of the shaft, *i.e.*, on to the bottom landing. The tubs from the cage on the upper deck have however gravitated to the tippler and to the point F, and it is therefore necessary to raise the tubs up an incline so as to allow them to gravitate back on to the top landing.

Automatic points (such as are employed at Newbattle Colliery) may be fixed at the point E, so that the number of tubs to each landing may be correctly governed without the aid of an attendant. It is therefore possible and practicable to arrange the roads so that not a single attendant will be required from where the tubs are discharged from the tippler to their respective positions on the top and bottom landings in readiness for putting into the cage.

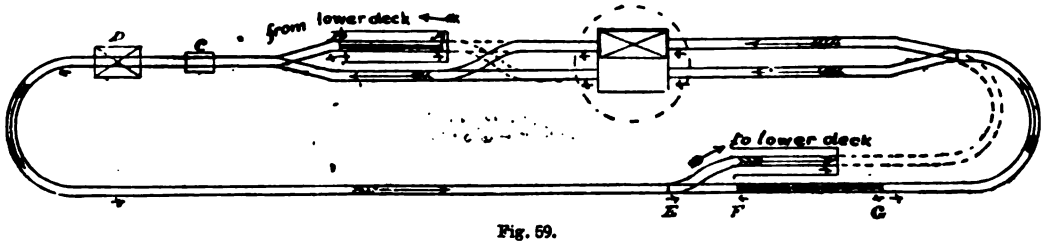

Fig. 59.

As all the economical arrangements hitherto described have depended upon the use of gravity roads, it would no doubt be useful to

* See last issue of "Mining."

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give the gradients commonly in use for such roads. Needless to say, much depends upon the state of the roads, tub wheels, &c., and in consequence the gradient required to give the tubs a fair velocity varies from 1 in 40 to 1 in 70 with full tubs, and from 1 in 30 to 1 in 50 with empty tubs. These figures do not refer to railway wagons on well kept roads but to colliery trams on straight roads. The inclination on curves will require to be much greater than for the straight roads, and the condition of the road has also a much greater effect. Creeper chains may be fitted to work at almost any reasonable inclination, but perhaps the limits of good working are from 1 in 3 to 1 in 10.

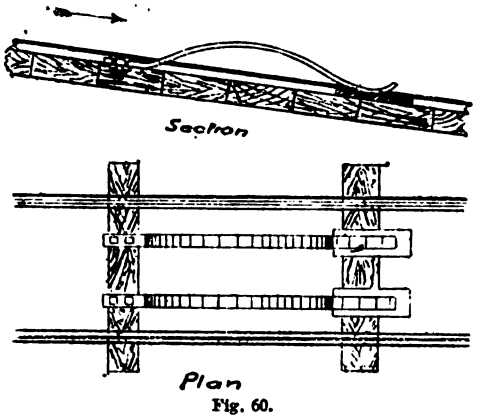

Fig. 60.

It often happens with modern arrangements of heapsteads that the return road for the empty tubs is at a considerable inclination, and the tubs would acquire too great a velocity in running down, and possibly smash each other, if some means were not taken to prevent it. The appliance commonly used to decrease the velocity of the tub consists simply of a spring board fixed in the road to catch the axles of the tubs, or fixed on each side of the road to catch the sides of the tubs; but this has several disadvantages, the tubs after depressing the end of the springboard and having possibly been raised might receive a shock, and the springboards require frequent renewal. Fig. 60 shews plan and section of a much better arrangement; the brakes consist of two curved straps of iron securely bolted at one end, but free to slide on iron plates at the other. They are fixed in the road as shown, and are sometimes fixed to catch the sides of the tubs.

Fig. 61 shews the arrangement of brakes when situated on the sides. They should be fixed at a height which would just allow them to catch the bottom of the sides of the tubs, as the tubs are strongest at this point. The two wedge pieces A A, and the axle and lever B, are an addition to the ordinary form of side brakes. These are placed at any point in the road where it may be required to block the

PARTICULARS OF WINDING AND BANKING AT VARIOUS COLLIERIES.

Name of Colliery.	Depth from surface.	Load.					Engine.					Time of Winding.	Average speed of winding.	Time of changing decks.	Maximum possible output per day of eight hours.	Remarks.
		No. of Wagons on Cage.	Weight of rope.	Weight of caged, wagons and chains.	Effective load, i.e. weight of coal per run.	Dead load at moment of starting.	Description.	Diameter of Cylinder.	Stroke.	Steam pressure.	Type and diameter of drum.					
	Yds.		Cwt.	Cwt.	Cwt.	Cwt.		In.	Ft. In.	Lb. per sq. in.		Sec.	Feet per second.	Sc.	Tons.	
Sneyed, No. 1	875	2	18	25	24	67	Horizontal coupled.	16	4 0	60	Koepe 10 feet	85	33·1	10	708	Single-deck cage; balance-rope.
Do. No. 2	920	6	56	76	65	197	Ditto	26	6 0	90	Slightly taper. 21 ft. 6 in.	55	38·9	25	1,170	Three-deck cage; decks changed separately.
Walsall Wood, No. 1	550	4	30	60	52	142	Ditto	42	6 0	65	Slightly taper. 20 ft.	44	37·5	10	1,285	Double-deck cage; both decks changed simultaneously; double platform.
Ditto. No. 2	550	2	30	32	26	88	Ditto	24	4 6	65	Koepe, 20 ft.	35	47·1	10	832	Single-deck cage; balance-rope.
Whitfield, No. 1	240	4	19	68	30	112	Ditto	24	4 0	65	Parallel 12 ft.	27	26·4	28	864	Double-deck cage; cages changed separately; balance-rope.
Ditto, No. 2	420	4	29	65	40	134	Vertical cpld.	36	5 0	65	Parallel, 20 ft.	40	31·5	10	1,152	Double-deck cage; cages changed simultaneously.
Denaby Main	450	6	46	72	60	178	Horizontal	40	6 0	70	Parallel, 24 ft.	50	27·0	10	1,440	Three-deck cages; decks changed simultaneously by a Fowler hydraulic banking-gear.
Newbattle Colliery, Lady Victoria Pit	552	12	80	140	120	340	Horizontal coupled	40	7 0	100	Parallel. 21 ft.	45	37·0	30	2,304	Two decks banked simultaneously; balance-rope.

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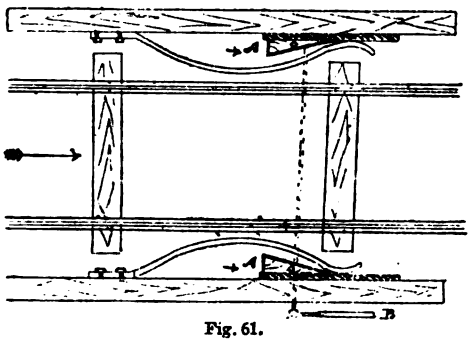

Fig. 61.

passage of the tubs. By means of the lever B the wedge pieces are moved forward in the direction of the arrows, and thus press the brake pieces closer together and effectually stop the passage of the tubs, though at the same time the shock which a tub coming at a great velocity sustains is not considerable as the application of the brake is gradual.

In concluding the articles on Winding and Banking, the foregoing table by Mr. E. B. Wain, A.M.I.C.E., read before the Institute of Civil Engineers will be of considerable value. The particulars of the last-named colliery in the table have been added by the writer of these articles.

EDITORIAL NOTES.

Our first duty in this issue is to offer all our readers a Happy and Prosperous New Year; this we do in all sincerity. As for ourselves, we hope the progress of our little journal will be as great during the coming year as it has been in the last.

* * *

At a meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers, on December 14th, Mr. H. St. John Durnford read a paper on "The Sinking of Acton Hall Colliery, with special reference to the thinning out of the Silkstone and Beeston Seams." Mr. G. Blake Walker called attention to a statement made in a paper read by Professor Lewes in London, in the spring, which he said had struck him with great force in connection with the explosion at Blackwell. Dealing with ordinary blasting powder as an unsuitable explosive for use in mines, Professor Lewes pointed out the one resulting constituent of its explosion was carbon-monoxide, and that carbon-monoxide was itself an explosive gas. Traces of carbon-monoxide when the air is ladened with coal dust will do exactly the same thing as when there are minute quantities of firedamp in the air with coal dust, whilst the temperature of ignition is lower than methane, so that when the air of the mine is charged with coal dust the probabilities are that a very large volume of explosive mixture is formed by the rapid escape of the products of combustion into the dust ladened air, and this (being ignited) initiates a considerable area of explosion. Mr. Walker pointed out that no gas was found either before or after the Blackwell explosion, but if Professor Lewes' theory was correct it furnished an explanation of an otherwise insoluble mystery, and it was decided to enquire further into the matter.

* * *

The American *Journal of Science* for the past month contains particulars of some experiments made by Professor A. Agassir, at the mines of the Calumet and Hecla Mining Company. The greatest vertical depth attained has been 4,712 feet, and observations have been taken from 105 feet to 4,580. The temperature at 105 feet was 59° F., and this may be taken as the depth unaffected by local variations in temperature; six other stations were made at increasing depths, or roughly, 550 feet, and finally a seventh, at 1,256 feet below the preceding one, by drilling holes to a depth of about 10 feet from the face of the rock; in these the recording thermometers were placed, the holes plugged with clay, and left from one to three months. The last temperature, taken at 4,580 feet, only registered 79° F., or 20° increase on the first, being an average increase of 1° F. for every 223·7 feet. "This," says Professor Agassir, "is different from previous observations, Lord Kelvin's being 1° F. in 59 feet, while the results based on observations of the St. Gothard Tunnel gave 1° F. for every 60 feet."

EARNOCK COLLIERY,

NEAR HAMILTON.

THE Earnock Colliery, on the estate of Mr. John Watson, of Earnock, and about 1,000 acres in extent, is situate about a mile west of Hamilton. The lessees are Messrs. John Watson, Limited; and Mr. John Moodie is the colliery manager

There are three shafts sunk near to each other. The thickness and depth of the four principal seams are as follows:—

	Ft.	In.		Yards
Ell coal	6	9	thick at	240
Pyotshaw coal ...	4	3	,,	258
Main coal ...	4	2	,,	262
Splint and virgin coals in one seam ...	7	2	,,	285

Nos. 1 and 2 pits have been in operation for about fifteen years, and No. 3 pit has been recently sunk. The mode of working is chiefly stoop-and-room, some portions of the "Pyotshaw" and "Main" seams being worked by longwall.

The pithead-framing and other surface erections are all of wrought iron or steel, the headgear of Nos. 1 and 2 pits being of wrought iron and 50 feet in height, while that of No. 3 pit is of rolled Bessemer steel girders and 65 in height.

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The colliery is drained by a Hathorne-Davey compound condensing engine, the high-pressure cylinder being 22 inches in diameter, and the low-pressure cylinder being 39 inches in diameter. This engine is situated in the main coal seam at a depth of 262 yards, near No. 1 shaft.

Ventilation is effected by means of a Guibal fan, 40 feet in diameter by 12 feet wide, producing 200,000 cubit feet of air per minute with 2·5 inches water-gauge, at a speed of 46 revolutions per minute.

The steam power is produced by seven Lancashire boilers, each 30 feet long by 7½ feet in diameter, at No. 1 shaft; and three Lancashire boiler at No. 3 shaft, each 30 feet long by 7 feet 9 inches in diameter; the latter being fired by Bennis mechanical stokers.

The output of Nos. 1 and 2 pits, which produce 1,200 tons a day of Ell and Main coal is raised by No. 1 pit, the No. 2 shaft being reserved for the raising and lowering of workmen and materials. The winding-engine at No. 3 shaft has two horizontal winding cylinders, each 28 inches in diameter by 60-ins. stroke, fitted with drums of 12½-ft. in diameter. The conductors in the shaft, one on each side of the cage, are flat-bottomed steel rails weighing 35 lbs. to the yard. The cages are two-decked, holding four tubs, and the winding-ropes are of plough steel, 1½ inches in diameter.

The winding.engine at No. 2 shaft has two horizontal cylinders, each 18 inches stroke, fitted with a drum 9 feet in diameter.

The No. 3 pit which is putting out over 500 tons a day of Splint coal, has a winding-engine with two horizontal cylinders, each 30 inches in diameter by 60 inches stroke, fitted with drums 16 feet in diameter. The conductors are similar to those used in No. 1 shaft, and the cages carry two tubs each, one above the other.

The principal haulage is by the main-and-tail-rope system, the gradients being sometimes with and sometimes against the load, and varying from level to 1 in 12 either way. The length of the roads traversed by this system are 2,480 yards in the "Ell coal" seam, and 1,240 yards in the "Main coal" seam; 30 to 40 tubs are run in each train in the "Ell coal" haulage, and 14 to 18 in that of the "Main coal" seam. The hauling-engines are situated near No. 1 shaft in the "Ell coal" seam.

There is a system of electric haulage, supplemental to the main-and-tail-rope haulage, doing the work of a number of horses that formerly hauled from the coal-faces to the termini of that haulage.

Two Westinghouse engines situated on the surface, running at 360 revolutions per minute, supply 60 brake horse-power direct to a line of shafting, from which three dynamos are driven by belts. One of the dynamos, which is that used for the haulage, generates power for two motors underground, and runs at a speed of 610 revolutions per minute. This dynamo is compound-wound and capable of producing a current of 100 ampères at 500 volts, equal to 67 horse-power. The other two dynamos are used in connection with the lighting of two mansion-houses on the estate. A copper cable connects the dynamo with the motors underground, one of which gives off to an endless rope haulage, 35 horse-power; and the other to another endless-rope haulage, 12 horse-power. Hurd clip-pulleys are use at the motors.

The surface-work and shaft-bottoms have been lighted by electricity since 1882. Three dynamos are driven by an engine with a cylinder 16 inches in diameter and 20 inches stroke, the speed of the dynamos and engine being in the ratio of 15 to 1. The dynamos are shunt-wound and supply electricity to 32 candle-power lamps for the pit's head, and a similar number is used underground.

There is a system of oscillating screens of perforated steel plates, delivering on travelling tables 30 feet long by 4 feet wide, where the round coal is picked and passed on to trucks. Conveyers are attached to which the small coal is taken to a Robinson washer, the nut coal being intercepted by a vibrating screen on the way. After being washed, the small coal is passed over several sizes of vibrating screens, and falls into the trucks as bean, pea, and pearl coal, while the duff coal is recovered by another process, and the water cleaned for use over again.

* From the Proceedings of the South Wales Institute of Engineers.

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A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

Assistant M.E.

First-class Certificated Colliery Manager.

(COMMENCED IN No. 9, VOL. III.)

ORIGINAL ABBREVIATED FORMULAE FOR CALCULATIONS OF SIZE OF WINDING ENGINES.

THE load of a winding engine is a quantity definitely fixed before the calculations of the engines are entered into, and are usually entirely independent of them. The tubs are to be of a certain capacity; and the possible cage speed and time for banking determine the number of tubs per wind. What the writer wishes to convey by these remarks is that questions requiring the size of engines and other arrangements necessary to wind a definite quantity of coal in a definite time are (unless the capacity of the tubs is stated) entirely misleading to the student as to the manner usually adopted in practice. The determination of the load will not, therefore, be discussed in this article, and it will be assumed that the load on the engine is known.

If no method of counterbalancing is adopted the load on the engine consists of the weight of the rope plus that of the minerals being wound, the tubs and the cages balancing each other. If the weight of the rope is counterbalanced, the load on the engine simply consists of the minerals wound.

The cage speed varies from 25 to 50 feet per second, generally increasing with the depth of the shaft. From 30 to 40 feet per second may be taken as the usual limit in shafts from 200 to 500 yards in depth.

The piston speed of the engine may be as much as 500 feet per minute, and with large engines even 600 feet per minute.

The stroke of the piston should be about twice the diameter of the cylinder. To give practical examples, the sum total of the diameters of the winding engines from the eight collieries given in the table in last issue is 21 feet 6 inches, and the sum total of the piston strokes is 42 feet 6 inches, which almost exactly coincides with the rule given.

The diameter of the winding drum is usually three times the length of the piston stroke. Taking averages for the six collieries given in the table where parallel or slightly tapered drums are employed the proportion is slightly in excess of that given, being about 3·5 to 1; but two of the number, including the largest and probably the most recently fitted up installation, are exactly in the proportion suggested. A number of text books give formulae for determining the size of the drum from the size of the rope, but the writer has very grave doubts of their utility, so far as winding is concerned.

A pair of engines with cranks coupled at right angles to each other and working direct are almost universally adopted, and as one engine may be at dead centre when the load is to be started, each engine is made capable of raising the load independent of the other.

The engines are calculated to do half as much work again as required to allow for friction of engines, etc.

The heaviest work which the engines have to perform is to start the load from rest; so that if the engines be calculated to do this they may be relied upon to do the remainder of the work.

It may perhaps be as well to remark that the three last statements are advocated by numerous authorities, including Greenwell, Merivale, Percy, and Fairley.

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So much by way of a foundation, and now to discuss the formulae for calculations.

The theoretical mechanical rule for finding the size of direct-acting engine required to raise a given load (neglecting friction) or *vice-versa*, is as follows:—

Area of cylinder in inches × twice the stroke of the piston in feet × the steam pressure in lbs. per square inch = circumference of drum in feet × load in lbs.

To make this rule practical we must calculate the engine to do 1½ times the actual work given; or what is really the same thing, the engine will in practice only do ⅔rds of the work theoretically shown.

To state the formula symbolically let—

A = Area of cylinder in square inches
S = Stroke of piston in feet
P = Effective steam pressure in lbs.
C = Circumference of drum in feet
L = Load on engine in lbs.

Also let—

d = Diameter of cylinder in inches
D = Diameter of drum in feet

(1) The mechanical formula, with half added for friction is as follows:—

$$A \times 2S \times P = C \times L \times \tfrac{3}{2}$$

$$\text{or } A = \frac{C \times L \times 3}{2S \times P \times 2}$$

When the area is found by this formula further calculation is necessary to find the diameter, viz.:—Divide area by ·7854 and extract the square root. To obtain the circumference of the drum also requires the diameter to be × 3·1416. These objections may be eliminated as the following will show:—

(2) Express A & C in terms of the diameters and substitute:—

$$A = d^2 \times \cdot 7854 \quad \text{or } \tfrac{1}{4} d^2 \times 3\cdot1416$$
$$C = D \times 3\cdot1416$$

Substituting in (1) we get—

$$\tfrac{1}{4} d^2 \times 3\cdot1416 = \frac{D \times 3\cdot1416 \times L \times 3}{2S \times P \times 2}$$

By cancelling, this becomes

$$d^2 = \frac{D \times L \times 3}{S \times P} \quad \text{or } d = \sqrt{\frac{D \times L \times 3}{S \times P}}$$

This latter formula is certainly much easier than (1).

There is a serious objection to both the foregoing formulæ; out of the five quantities, four at least must be known to calculate the fifth, and as two of these (the diameter of cylinder and length of stroke) are required to be proportionate, if the calculation is to find both of these, a difficulty arises. The method usually adopted to overcome this difficulty is, to say the least of it, scarcely mathematical. It is as follows:—Assume a length for the stroke of piston, and if this does not work out to a fair proportion of the diameter of the cylinder, assume another and *try again*.

Now as we know the proportion we require between the diameter of the cylinder and the length of the stroke to be as 1 to 2, why not express one in terms of the other and thereby reduce the two unknown quantities to *one*, thus

(3) Express the stroke in terms of the diameter. Then stroke = diameter × 2; but as the stroke is in the formula expressed in feet and the diameter is expressed in inches—

$$S = \frac{2d}{12} \quad \text{or } S = \frac{d}{6}$$

Substituting in (2) we get

$$d^2 = \frac{D \times L \times 3}{\frac{d}{6} \times P} = \frac{D \times L \times 18}{d \times P}$$

$$\text{or } d^3 = \frac{D \times L \times 18}{P} \quad \text{or } d = \sqrt[3]{\frac{D \times L \times 18}{P}}$$

When d is found, S can be ascertained by multiplying by 2.

This formula may not be considered convenient to those unacquainted with cube root, but it is certainly preferable to either of the preceding ones. If either the steam pressure, the load, or the diameter of the drum is required No. 2 is the best method for calculation.

A still better method of overcoming the difficulty of the length of stroke can be arranged if we determine to make the diam. of the drum three times the length of the stroke. A very simple and abbreviated formula can then be deduced, probably the simplest yet brought forward, and one which possesses the merit of being correct and no approximation.

(4) Express the diam. of drum in terms of the length of the stroke.

$$D = 3S$$

Substituting in No. 2 we get

$$d = \sqrt{\frac{3S \times L \times 3}{S \times P}}$$

The S in each case will cancel out and we get

$$d = \sqrt{\frac{L \times 9}{P}} \text{ or } d = 3\sqrt{\frac{L}{P}}$$

Having found the diameter of the cylinder by this last formula, the piston stroke may be made *any* suitable length, but the diameter of the drum *must be* three times the length of the piston stroke. For example, assuming that the diameter as found by the formula (4) was 12 inches, then it would not affect the accuracy of the result whether a 2 ft. stroke and a 6 ft. drum were adopted, or a 2ft. 6in. stroke and a 7 ft. 6 in. drum.

(*To be continued.*)

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FAIRHILL COLLIERY,*

HAMILTON, N.B.

THIS colliery, which belongs to Archibald Russell, Esq., is fitted up for an output of 1,000 tons per day. There are two oblong winding shafts, each 22 feet by 6½ feet wide, sunk to a depth of 393 yards. Both pits are lined with 5-inch pitch-pine boarding at the surface and 3-inch white-pine at the bottom.

The winding-engine at the No. 1 or downcast pit has two horizontal cylinders, each 24 inches in diameter. The steel winding rope is 3½ inches in circumference. The cage weighs 18 cwt., and lifts two hutches, each weighing 4 cwt., and holding 10 cwt. of coal, the total working load being 2 tons 6 cwt.

The horizontal winding-engine at the No. 2 or upcast pit has two cylinders, each 24 inches in diameter and 4½ feet stroke. The winding drums are 12 feet in diameter, and the appliances are similar to those at No. 1 pit.

The ventilation is produced by a *quasi*-Guibal fan, receiving air at both sides. The fan is 24 feet in diameter and 7 feet wide, and is driven by an engine with a cylinder 16 inches in diameter and 2½ feet stroke.

The horizontal pumping-engine has one cylinder 20 inches in diameter and 4 feet stroke. It is geared 5 to 1, and makes 9 strokes per minute. The top lift of the pumps has a 14-inch bucket, and the bottom lift a 13-inch bucket, and the engine is lifting 420 feet from the bottom lift. A small Worthington pump is placed in the shaft at a depth of 84 feet.

There are eight boilers of the egg-ended type, each 30 feet long by 5½ feet in diameter, working at a steam pressure of 50 lbs. per square inch, fitted with patent dampers, and fed by a Hulme and Lund vertical donkey pump, with a Worthington donkey pump in reserve. The exhaust steam from the winding engine is used to heat the feed-water.

The cleaning plant consists of a slow-motion jigger and picking tables, for cleaning the round coal and making nuts.

Three seams are now being worked, the "Ell coal," 7 feet thick, at a depth of 247 yards; the "Main coal," 4 feet thick, at a depth of 272 yards; and the "Splint coal," 7 feet thick, at a depth of 293 yards. These seams are all worked on the stoop-and-room system. Horses are used for the underground haulage. The surface and pit bottom are lighted by electricity.

BARDYKES COLLIERY,*

BLANTYRE, N.B.

THIS colliery, which belongs to Messrs. Merry and Cunninghame, Limited, has two oblong shafts, each 22 feet long by 7 feet wide. The No. 1 pit is sunk to the Splint coal seam at a depth of 440 yards. The seams worked are "Ell coal," 8 feet 9 inches thick, at a depth of 380 yards, and "Main coal," 3 feet 6 inches thick, at a depth of 408 yards. Both seams are worked on the longwall system. This pit is used as a downcast and pumping shaft.

This pumping-engine is of Cornish type, with a cylinder 84 inches in diameter and 8-foot stroke. The pumps have a stroke of 9 feet, and consist of 22-inch, 20-inch, 18-inch, and 13-inch ram, with a lift of 300 feet each, and one 8-inch bucket with a lift of 120 feet.

The winding-engine has two cylinders, each 28 inches in diameter and 5-foot stroke, and draws four hutches, each containing 11 cwt. of coal at a time.

The No. 2 and upcast pit is also sunk to the "Splint coal" seam, the seams worked being the "Upper" or "Glasgow coal," 2 feet 9 inches thick, at a depth of 360 yards, and the "Ell coal" is in No. 1 pit.

The mine is ventilated by a Guibal fan, 30 feet in diameter and 10 feet wide, and a Waddle fan 45 feet in diameter is held in reserve.

The winding-engine has two cylinders, each 24 inches in diameter, and draws two hutches at a time.

The coal worked from both pits is brought to a central screening station, and is deposited by means of revolving tipplers on shaking screens; thence to Lührig picking-bands, where the lumps are prepared for market. The small coal or dross is elevated into a large sizing-drum, and divided into treble, double, single, and gum coals. These products are then washed in separate jigging boxes, and dropped into hoppers ready for trucking. The plant is capable of treating 1,500 tons, and of washing 600 tons of small coal per day of 10 hours. The present output is 800 to 900 tons per day of 9 hours.

* From the Proceedings of the South Wales Institute of Engineers.

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EXAMINATION QUESTIONS,

WITH ANSWERS BY

J. CARTER, First-Class Certificated Manager.

Questions given in the South-Western District, Sept., 1894, for Managers' Certificates of Competency.

(The figures in parenthesis show the number of marks obtainable.)

(Continued from last issue.)

No. 3 Subject.

GASES & VENTILATION.—Continued.

(110 marks to qualify.)

QUESTION 8.—The water-gauge at the fan drift of a colliery stands at 2 inches when the quantity of air passing is found to be 150,000 cubic feet per minute. What quantity would you expect to pass with the same expenditure of ventilating power if the water-gauge rose to 2·5 inches, owing to increased resistances in the airways? (20)

ANSWER.—Quantity of air varies as the square root of water-gauge:—

$$\therefore \frac{150000 \times \sqrt{2}}{\sqrt{2{\cdot}5}} = \frac{150000 \times 1{\cdot}4142}{1{\cdot}5811} =$$

134166 cubic feet of air per minute.

No. 4 Subject.

PRACTICAL MINING & GEOLOGY.

(100 marks to qualify.)

QUESTION 1.—Describe the provisions of the Coal Mines Regulation Act of 1887 with regard to dangerous practices not expressly prohibited. (20)

ANSWER.—Should an inspector find in any mine or part thereof any matter, thing, or practice in or connected with any such mine, or control, management or direction thereof by the manager to be dangerous or defective (although not provided against by any express provision in the Act or by any special rule) so as in his opinion to threaten or tend to the bodily injury of any person, he may give notice in writing to the owners, agent, or manager of the mine, stating the particulars thereof in which he considers the mine, or part thereof, or any matter, thing, or practice to be dangerous or defective, and require the same to be remedied forthwith, failing this he shall report the same to the Secretary of State.

Notice of objection to remedy the matter complained of may be given in writing by the owner, agent, or manager of the mine within ten days after the receipt of such notice. The grounds of objection must be clearly stated and forwarded to the Secretary of State, when the matter shall be determined by arbitration in the manner provided by this Act. Date of the receipt of objection shall be deemed to be the date of reference. When no notice of objection is sent as aforesaid, should the owner, agent, or manager fail to comply with the requisition of the notice within ten days after the expiration of the time for objection, or when there has been an arbitration to comply with the award within the time fixed by the same, he shall be guilty of an offence against this Act, and the notice and award shall respectively be deemed to be within notice of the offence.

Provided that the Court, if satisfied that the owner, agent, or manager has taken active measures for complying with the notice or award but has not, with reasonable diligence, been able to complete the works, may adjourn any proceedings taken before them for punishing the offence, and if the works are completed within a reasonable time no penalty shall be inflicted.

No person shall be precluded by any agreement from doing, or be liable under any contract to any penalty or forfeiture for doing such acts as may be necessary in order to comply with the provisions of this section.

QUESTION 2.—Draw a section of the seam, floor, and roof with which you are best acquainted, at any colliery, and illustrate with sketches how the seam is worked at the face. (20)

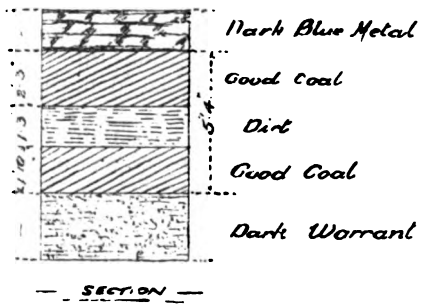

Fig. 1.

ANSWER.—Fig. 1 shows a section of a mine which has a roof of dark blue metal, 3 feet thick. The top coal is 2 feet 3 inches thick, of a fair quality, and is divided from the bottom coal by a layer of dirt 1 foot 3 inches, which is intermixed with streaks of inferior coal, all of which is packed behind; below this the coal is 1 foot thick and of good quality. The floor consists of 4 feet of dark soft warrant. This mine is worked in long-wall, for which it is best suited, because of

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there being plenty of refuse for packing. The colliers hole in the dirt and inferior coal, and

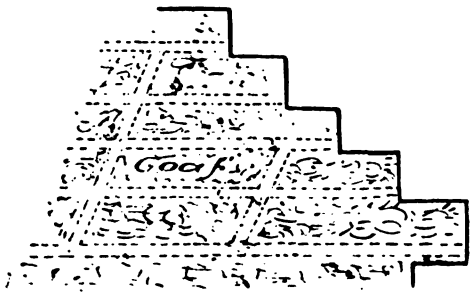

Fig. 2.

pack it behind them to form the road. Fig. 2 shows the method of working adopted drawing roads being about 14 yards apart, and the faces are worked in steps as seen in sketch.

QUESTION 3.—Describe the duties of a colliery manager as laid down in the Coal Mines Regulation Act of 1887. (20)

ANSWER.—A manager is responsible for the control, management, and direction of the mine or mines under his charge, and in his directing the system of working such must have in view the safety of the workmen employed. Therefore, his duties are to see that the C.M.R.A. is carried out and to the best of his power enforce the observance of the provisions contained therein.

In order to assist him in carrying out the Act he shall appoint a competent person or persons when in his judgment they may be required. Each person so appointed must be informed of his special duties and the district or districts of the mine or colliery to be under his charge. If an under-manager is employed, his special duties must likewise be defined by the manager. He shall see that the provisions contained in the following rules are carried out:—

General Rule 1.—An adequate amount of ventilation to be constantly kept, and the quantity of air to be measured at least once a month in each split and recorded in a book.

General Rules 8, 9, and 10.—As to locked safety lamps, construction of safety lamps, locking of safety lamps, and appointing of a competent person or persons for the examination of same in accordance with sections 1, 2, 3, and 4 of general rule 10.

General Rule 11.—The fixing of lamp stations, also fixing of stations in accordance with general rule 4.

He shall from time to time determine the kind of explosives to be used below ground, and in accordance with general rule 12 shall specify as to the watering of places requiring such treatment.

In places requiring boreholes in accordance with general rule 13, such holes he must direct where to be made.

In further reference to safety lamps he shall see that the special rules relating to them are carried out.

He must see that a barometer and thermometer are placed at the entrance to the mine in accordance with general rule 33.

In addition to the above, in compliance with the Act, it is his duty to see that all books required by the Act are kept and duly entered up. Plans of the mine or mines, notice of accidents and yearly returns to be made. Also he shall see that the abstract of the Act and a copy of the special rules are published (posted up) and supplied in accordance with section 57 of the Act. In fact the whole of the C.M.R.A. with its sections and sub-sections, in addition to the special rules, must have his most careful attention, and to the best of his power must see that they are carried out.

QUESTION 4.—Several shots have to be fired in a dusty and fiery mine. What precautions should be observed by the shot-lighter? (20)

ANSWER.—I will here refer the student to general rule 12, sections *f* and *g* with its sub-sections 1 and 2. Also sections *h* and *i* with their sub-sections 1 and 2.

QUESTION 5.—Explain the action of a syphon and give an example of its application to mining. (20)

ANSWER.—The syphon depends for its action on the pressure of the atmosphere, and an example of its practical application is the drainage of dip workings of a mine. The principle of its action will be best understood by reference to the sketch. The syphon consists of a length of pipes bent so as to form two legs of unequal *vertical* height. The practical limit of height to which water can be raised is about 20 feet, so that the intake end of the pipes should not be more than this vertical depth below the highest point; and the delivery end of the pipes must be considerably lower than the intake end. To make the syphon work, it is first necessary to completely fill the pipes with water, this

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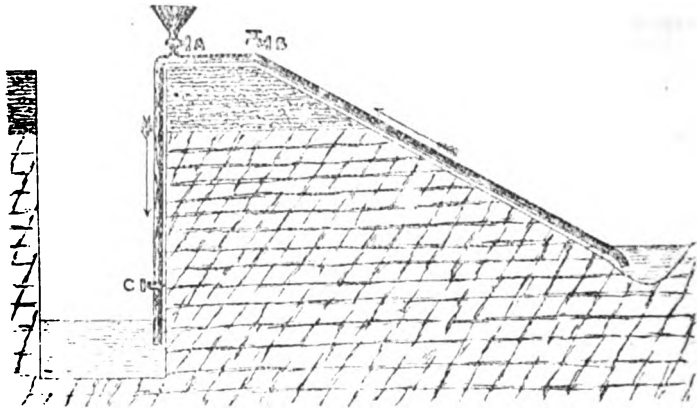
may be done by means of the funnel at the top of the pipes. The taps A and B are then shut off, and all air is prevented from entering the pipes. The tap C is then turned on and the water flows down the delivery end of the pipes and thus creates a vacuum. The atmospheric pressure being about 15 lbs. to the square inch forces the water up the intake end of the pipes to fill up the vacuum caused by the water flowing down the other leg of the syphon, and a continual flow is thus obtained. The intake end must always be immersed in water, or air will enter the pipes and prevent it working, for the same reason the delivery end should be immersed in water or slightly turned up at the bottom to prevent the air gurgling up.



QUESTION 6.—In proving a fault in a coal seam, what operations would you order to win the coal? Illustrate your answer by a sketch or sketches. (20)

ANSWER.—Drive a road through the fault, and if the strata is not recognisable, bore a hole in the direction of the greater angle formed by the fault and the seam.

(To be continued.)

THE CHANNEL TUNNEL AND COAL UNDER THE SEA.

THE Secretary of the South-Eastern Railway Company has informed the *Westminster Gazette* interviewer that the experimental works of the Channel Tunnel have been entirely suspended and the heading has been closed altogether. The capital sunk at present amounts to something over £129,000, but only about 27,900 of the £1 shares have been fully paid up, and the shareholders are quite content to wait—confident that they will be able to go on with the work before long. The Company were determined to quietly wait until public opinion had changed. Even now they had a very large section of the public on their side. The chief opponents were, of course, Lord Wolseley and the military authorities. As for the practicability of the scheme, "If only we were allowed to go on," said the Secretary, "there is no doubt of it." The Secretary in answer to a question as to whether the search for coal had been discontinued said, "Yes, that is quite true; but the abandonment is quite temporary—far more so than that of the tunnel works. The facts of the case are that we do not intend to spend any more of the Tunnel Company's capital over it, and the works will remain closed until the establishment of the new colliery company now in process of formation." "Then you are still sure there is plenty of coal there that can be got out at a profit?" "We are certain of it. All the reports that have been made have been most satisfactory, though of course the vein lies to a great extent out seawards and fairly deep down, about 200 feet or more. The coal there corresponds to that in the West of England, and we are sure we shall have little difficulty in getting the capital and deriving from the colliery a liberal return for it."

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THE DRY PROCESS AS APPLIED TO GOLD MINING.

THE more extended introduction of dry crushing in the gold mining industry in connection with the Leaching Process, particularly with Cyanide, has necessitated the production of new and improved machinery and has given a considerable impetus to English and Foreign Mining Engineers. This will be readily appreciated when we mention that by the wet process with stamp batteries and amalgamation as hitherto employed in mines where the precious metals are finely diffused throughout the ore, never more than 25 to 30 % can be saved and although by adding pans this may, at considerable expense, be increased, even then it rarely exceeds with the two operations 60 %. By the dry process however, with crushing rolls followed by efficient leaching it is proved that over 90 % of the gold may be recovered. It will therefore, we feel sure, be of considerable interest to our readers at the present time, to have before them particulars of some of the most modern and improved machinery that can be obtained as well as a general description of the method of treating the gold ore on this dry process.

The quartz as usually brought in trucks in large lumps to the reduction mill (where it has to be treated) is tipped on to what is termed a grizzly, from whence it is fed into a stone or quartz breaker; this machine with its powerful jaws reduces the large lumps of quartz into pieces about the size of an egg; this broken material is then taken by an elevator, and passing through a screen which removes any sufficiently small stuff, enters a second and finer set stone breaker which still further reduces the quartz to about the size of a nut. The quartz, thus twice broken, now enters another screen, which takes out a certain proportion of the powdered ore, and the larger portion of the ore which is still too large to pass through the screen is then conveyed to the crushing rolls, which in fact, perform the main and chief part of the operation. The rolls have a smooth hard surface, and the finely broken ore is passed through these rolls until it is reduced to a properly crushed and pounded condition. The product from the rolls is next taken by an elevator to the third or finishing screen which may have perforations of any desired fineness, and on leaving this third screen the ore is delivered in a finely granulated condition ready for concentration or leaching by the cyanide or other process. An important feature in this arrangement with rolls is, that any product too coarse to go through the third screen is returned to the rolls and so crushed again, until sufficiently fine to be passed by this screen to the hopper receiving the completely finished ore.

The machinery may be driven by a steam engine of any design, or by water or other power as preferred or available. The plant under notice is capable of dealing with a ton to a ton and a half of quartz per hour, or say 25 to 35 tons per day of 24 hours, the finished product passing through a 40 mesh, that is, a screen or sieve having 1,600 holes to the square inch. It should be mentioned that manual labour is almost entirely dispensed with, from the time the rough quartz is fed into the stone breaker to the time it is delivered in a finished condition from the third screen.

The plan of the reduction mill we have described has been designed by Messrs. Julius Harvey & Co., Engineers, 11, Queen Victoria Street, London, E.C., assisted by the experience and advice of practical Mining gentlemen from the colonies.

We should mention that larger arrangements are supplied with two or more sets of rolls, as also any other class of Machinery that may be necessary to suit the special requirements of clients, or the particular nature of the quartz to be operated upon.

THE SOUTH YORKSHIRE & DURHAM COALFIELDS.*

By Mr. FRANK BAKER, C.E., F.G.S.

THIS coalfield, measured along a line ranging north and south from a point ten miles west of Nottingham to the eastern suburb of Leeds, is about sixty-five miles in length; its breadth at the northern end, immediately south of Leeds and Bradford, is twenty-one or twenty-two miles, and it gradually narrows southward, being at Sheffield—which is nearly at its centre—about thirteen miles wide. It varies in Derbyshire from seven to ten miles. On its eastern margin it is overlaid unconformably by the magnesian limestone of the permian formation. On the west the coal measures rest on a series of thick coarse sandstone with interbedded

*Extract of Paper read before the Cleveland Institute of Engineers.

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shales and occasionally a thin coal, known collectively as millstone grit. This forms the high bare moorland, which from the Peak of Derbyshire northward, divides the coalfields of Yorkshire and Derbyshire. The coal measures are divided into the lower coal measures or beds below the Silkstone coal, and the middle coal measures, which include almost all the beds of any importance. In addition may be mentioned the only rocks classed as upper coal measures, the red beds with coal plants seen at Conisborough Pottery. Most of the upper coal measures were removed by denudation, previous to the unconformable deposition of magnesian limestone above the carboniferous strata. The lower coal measures are more remarkable for massive sandstone forming well-marked escarpments than for coal. Few of the coals are of more than local importance. The Gannister and Whinmoor coals are the only ones of this series worthy of notice about Sheffield. In the middle coal measures the Silkstone coal—the lowest of the important beds—is perhaps the first in point of reputation, the Barnsley coal being held in little less esteem; other coals exist between these two and above the Barnsley of fair thickness and quality, but they are not worked near Sheffield, as they cannot compete with the Silkstone and Barnsley seams. Coal with other names and on different horizons are worked about Wakefield, Leeds, Halifax and Bradford.

Then above these measures, rich in coal, are, towards the upper or eastern boundary of the coalfield, a series of measures with few coals and few thick or massive sandstones. Leaving Sheffield in a westerly direction by the Glossop road, the outcrop of the Silkstone coal is passed near the spot on which Gill street crosses. A gradual ascent follows the Stephen Hill near which the fault ranging north-east and south-west crosses the road, which here divides the lower coal measures from the millstone grit.

With regard to the middle coal measures, the direction of the lines of outcrop south of Sheffield is north-west to south-east. But from Sheffield northward two great faults, throwing down the measures between them, alter the strike of the beds so much that their outcrops are at right angles to their direction, immediately south of Sheffield—viz., south-west and north-east—which is also the direction of the line of fault. These two faults are known as the northerly and southerly Don faults. The northerly fault ranges from half to two-thirds of a mile west of the alluvium of the Don. The southerly fault is, roughly speaking, parallel to the northerly fault, and for some distance keeps on close to the river and its alluvial flats. The Silkstone and Parkgate coals recover their former line of strike about three miles north of Sheffield, but some of the higher beds retain the strike induced by the faults for a much greater distance. The Parkgate is the first coal of any importance met with above the Silkstone, which is about 100 yards below it. The Silkstone and Parkgate rocks which overlie the coal so named, form, with the measures between them, the steep hill-side east of the Sheaf and on which St. John's Church stands, and they may be traced in a south-eastern direction towards Norfolk Park and intake. Towards Crookes are the lower coal measures, which there attain a height of 825 feet above the sea level, or about 650 feet above the alluvial flats of the Don and Sheaf. In the middle and lower divisions of the Yorkshire coalfield there is an aggregate thickness of 40 feet to 50 feet of coal in nearly 3,000 feet of coal measures.

Four tons of wood are required to yield the charcoal which we find in a ton of coal. A coal bed 3 feet thick and one acre in extent must be the growth of 1,940 years. But if the vegetation was like that of a tropical climate 1,000 years would still be needed to form a bed of coal a yard thick, and for 36 yards of coal in the Midlothian field a period of 36,000 years. In making a comparison between the South Yorkshire and Derbyshire and the Durham and Northumberland coalfields, the South Yorkshire and Derbyshire is the largest in England, having 900 square miles, the greatest thickness of productive coal measures including the lower series 4,500 feet, the average number of workable coal seams above 2 feet fifteen, giving a vertical thickness of 46 feet of coal; average number from 1 foot upwards, twenty, with 53 feet of coal; net quantity of coal available for comsumption down to 4,000 feet, over 12,000 millions of tons. In Durham and Northumberland the area of the visible coalfield beyond the limits of the permian and new red sandstone, 460 square miles; area of concealed coalfield 225 square miles; area under the sea supposed to be available, 111 square miles; number of workable seams from 18 inches upwards, sixteen; giving a thickness of available coal of 46 feet; quantity of coal available for consumption, between 6,000 and 7,000 millions of tons.

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ANSWERS TO COMPETITION QUESTIONS

GIVEN IN No. 2, VOL. IV.

WATER-GAUGE.

(1) An upcast and a downcast shaft are each 16 feet diameter, the former 190 yards and the latter 200 yards deep; the airways in the mine are four in number, the frictional resistance in each being equal to that in an airway 6 feet by 4 feet and 1000 yards long. What pressure should the water-gauge show in the upcast when 30,000 cubic feet of air is passing per minute?

Answer.—The pressure producing ventilation is equal to the following equation:—K the co-efficient of friction for square foot of rubbing surface, and V the velocity in thousands of feet per minute, P the pressure per square foot producing ventilation, and A the area of section. Then

$$P = \frac{K\,S\,V^2}{A}$$

I will take the downcast first and get the pressure and w.g.

Per = 16· × 3·1416 = 50·26.

S = (200 × 3) × 50·26 = 30156.

A = 16· × 16· × ·7854 = 201·06

$$V = \frac{Q}{A} \therefore \frac{30000}{201{\cdot}06} = 149 = \frac{149}{1000} = {\cdot}149.$$

$$P = \frac{{\cdot}0217 \times 30156 \times {\cdot}149 \times {\cdot}149}{201{\cdot}06} = {\cdot}07 \text{ lbs.}$$

pressure per square foot.

$$W.G. = \frac{{\cdot}07}{5{\cdot}2} = {\cdot}01346.$$

In the first place I would say that to pass 30000 cubic feet down the downcast will require ·07 lbs. pressure per square foot with a w.g. of ·01346

Then the airways or splits are 4, so we will divide $\frac{30000}{4} = 7500$ cubic feet passing in each.

Per = 20.

S = (1000 × 3) × 20 = 60000. A = 24.

$$V = \frac{Q}{A} \therefore \frac{7500}{24} = {\cdot}312.$$

$$P = \frac{{\cdot}0217 \times 60000 \times {\cdot}312 \times {\cdot}312}{24} = 5{\cdot}23 \text{ lbs.}$$

pressure per square foot.

$$W.G. = \frac{5{\cdot}23}{5{\cdot}2} = 1 \text{ inch.}$$

Then for underground airways it would take a pressure of 5·23 lbs. with a w.g. of 1 inch.

Then upcast—

Per = 16 × 3·1416 = 50·26.

S = (190 × 3) × 50·26 = 28648·2.

A = 201·06.

$$V = \frac{Q}{A} \therefore \frac{30000}{201{\cdot}06} = \frac{149}{1000} = {\cdot}149.$$

$$P = \frac{{\cdot}0217 \times 28648 \times {\cdot}149 \times {\cdot}149}{201{\cdot}06} = {\cdot}06 \text{ lbs.}$$

pressure per square foot.

$$W.G. = \frac{{\cdot}06}{5{\cdot}2} = {\cdot}013$$

Pressure for upcast, ·06 lbs. per square foot.
W.G., ·013

Total pressure—

Downcast...	·07
Airways.....	5·23
Upcast	·06
	5·36

I would expect the W.G. to be 1·03, as

$$\frac{5{\cdot}36}{5{\cdot}2} = 1{\cdot}03$$

That is, with one leg of the W.G. inserted in fan-drift and the other exposed to the atmosphere; but if steam pipes are led down the upcast, or the engines exhaust into the upcast, the W.G. might read less, or it might read at the bottom of upcast and fan-drift the same. THOS. E. AITCHISON.

PILLAR WORKING.

(2) Give your experience in taking out coal pillars. Describe how you would protect yourself from falls of roof. Give sketches.

Ans.—Having had a few years' experience in the removing of pillars, or what is known as "brokens" or "pillar working," I will just give a few remarks showing how I would remove the pillars and at the same time how I would try to prevent accidents from falls of roof and coal. There are two different kinds of pillars which are to be removed in the bord and pillar system of working.

Firstly, pillars which have been supporting the main haulage or other important roads may have been standing for years and have in most cases to be opened out, *i.e.*, the old

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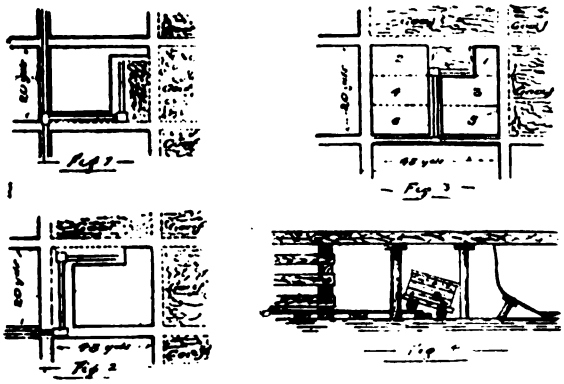
roads cleared or ridden out. In removing these pillars a "jenkin" is driven, about 3 yards wide, along the lower side of the pillar in a bordway direction, or at right angles to the cleat of the coal. When this reaches the end of the pillar it is then removed in slices. These slices are termed "headway lifts," and are about 6 yards wide. It will be seen that if the pillars are 48 yards long and 20 yards wide it will take 8 lifts of 6 yards wide and 17 yards long to remove the whole pillar. Fig. 1 shows a pillar being removed in this manner. Supposing that the main haulage raods are narrow bords, then the pillars will have to be opened in a headway direction, which is accomplished by driving a "skirting" up the outbye end of the pillar. When this reaches the other side of the pillar it is removed by a series of bordway lifts driven about 5 yards wide, so that four of such lifts would remove the whole pillar. Fig. 2 shows this method of removing a pillar.

Secondly, pillars which are removed just after they have been formed. This system is known as following the whole up with the "brokens." These pillars are removed as shown in Fig. 3. A place is driven across the middle of the pillar termed a "split;" the pillar is then removed by a series of short lifts being taken out on each side of the split in a right and left direction. No. 1 is taken out first, then No. 2, and so on.



By referring to Figs. 1, 2, and 3, it will be seen that on each side of the tramway the roof is well secured with timber. In the lifts the roof needs extra support; here I would build strong chocks next to the goaf side in addition to the timber supports. If the goaf yielded large stones I would use ·uilding packwalls alongside of the ·, these lifts cannot be kept too safe for the workmen. Figs. 1, 2, and 3, show the plan of how and where I would place the chocks. In Fig. 4 will be seen a section of a lift, in which is shown the method of spragging the coal to protect the workmen, and the position of the timber, which is kept as near the coal face as possible.

In my answer I may have used terms which are used in this district, and they may not be so clear to other students, therefore, I think it will not be out of the way if I explain them. A "jenkin" is a place driven in the coal by the side of an old place at right angles to the cleavage. "Lifts," this is taking large slices of coal off a pillar either at right angles or parallel to the cleavage. "Skirting," a place driven in the coal by the side of an old place parallel to the cleavage of the coal. "Split," a place driven through the middle of a pillar in any direction, which renders the pillar of coal easy to lift off or remove. GEORGE DAYKIN.

POSITION OF WATER-GAUGE IN FAN-DRIFT.

(3) Where is the best place for placing the water-gauge for ascertaining the ventilating pressure at a fan drift? Give your reason and illustrate your answer by a sketch showing the position of the water-gauge.

Answer.—The best place for placing the water-gauge so as to ascertain as nearly as possible the correct ventilating pressure at the fan-drift is to have it at a certain distance from the fan for the following reasons:—(1) Fix the water-gauge, say 10 feet or more back in the fan-drift, there is then every possibility of getting the correct reading of the ventilating pressure. (2) By placing the water-gauge at this distance oscillation of the level of water in the two legs is prevented. (3) The water-gauge must be fixed so that the open tube leg will be parallel with the return current towards the fan, by so doing oscillation is obviated from the wafting of the fan blades as they turn round in their path, or in other words it must be placed at right angles to the air-current. (4) The end of the pipe going to the water-gauge should be loosely covered with cotton-wool or a roll of felt, plugged at the top with wool, so as to cause the air to pass through the wool and thus prevent the objectionable eddies of the current produced by the fan from taking

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effect upon the water-gauge. (5) By placing the water-gauge at the point as per sketch in the fan-drift it will record the whole resistance which is produced by the rubbing surfaces of the airways, commencing at the downcast and terminating at the fan-drift. In fact, the proper position to fix the water-gauge is about 10 feet at least away from the entrance to the fan-inlet, but there is a considerable difference of opinion as to the right position of fixing the water-gauge. The English Fan Commission placed the gauge 6 feet from the entrance to the fan-inlet. This, however, is thought by many mining engineers to be far too near the machine, and especially so if small high-speed fans are used, because the eddies of the air-current, produced by rapid revolution of the fan, are likely to give false results on the gauge.

SAMUEL DAVIES.

[Sketch missing, but the text is sufficiently explicit to render it unnecessary.—ED.]

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before February 7th, 1896.

We invite readers to forward questions for this competition.

(1) A vertical column of cast-iron water pipes is 300 feet long; the upper portion for 200 feet is of 12 inches diameter, and the lower portion of 100 feet is of 10 inches diameter. Required the weight of pipes and water, and the pressure of the water per square inch on the bottom.

(Only answer and method of ascertaining same required.)

(2) How would you work two seams of coal dipping 1 in 3 of the following section:—

Hard Shale.....	Roof
Coal	3 feet
Light Warrant	3 to 10 feet
Coal	3 feet
Strong Warrant.....	Floor

Give suitable sketches to illustrate the answer.

(3) In driving a pair of levels you meet an up-throw of 50 yards. What size of tunnels would you drive, and at what gradient? What distance apart would you cut openings through, and what would be the length of the tunnel?

EDITORIAL NOTES.

The Home Office has just issued the first annual report on the Mineral Industry of the United Kingdom. It has been compiled by Dr. C. Le Neve Foster, in accordance with the recommendation of the Royal Commission on Mining Royalties, and the Departmental Committee on Mining and Mineral Statistics. The present report gives a comprehensive idea of the condition of the mining industry as a whole during the year 1894. According to the report the number of persons employed in and about all the mines of the United Kingdom and Isle of Man during the year 1894 was 739,097, of whom 589,689 worked below ground and 149,408 above. The following table shows the proportion of persons employed, and the percentage of deaths from accidents at each coalfield:—

Coalfield.	No. of Mines.	Percentage of total number employed.	Percentage of total number of deaths from accidents.
Scottish	525	12·8	10·1
Northern.....	381	19·7	12·7
Yorkshire, &c.	664	22·7	13·0
Lancashire & Cheshire	463	12·7	9·0
Midland	547	9·2	7·3
Small detached	141	3·0	2·0
North Wales	68	1·8	2·4
South Wales	537	18·0	43·5
Irish.....	21	0·1	—
	3347	100·0	100·0

* * *

The annual conference of the Miners' Federation of Great Britain was commenced at Birmingham, on Tuesday, the 13th inst. The President (Mr. B. Pickard, M.P.) delivered an address dealing generally with the past and future of the mining industry.

* * * *

At the meeting of the Cleveland Institution of Engineers, held at Middlesbrough, on the 18th inst., Mr. Frank Baker, C.E., F.G.S., read a paper dealing with the South Yorkshire and Durham coalfields.

* * *

The Abertillery Colliery Company (Mon.) have after arduous search during the past three years struck the valuable vein known as the "Tillery Seam." The seam is situated east of the Abertillery big fault, and consists of three layers of coal measuring 4 feet 6 inches in thickness altogether, including a layer of rubbish 1 foot thick.

* * *

At a meeting of the members of the Institution of Civil Engineers, a paper was read by the Hon. R. C. Parsons, M.A., M.I.C.E., on "The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water Supply."

* * *

A correspondent of the *Wigan Observer*, with the *nom-de-plume* of "A Democratic Pitman," writing on "Accidents in Mines," compiles half of his contribution with unaccredited extracts from an article which we published on "Accidents in Mines and their Prevention," in No. 18 of Vol. III. The following is an example of some of the statements made in the remaining half of his letter. "Prop drawing has been responsible for loss of life, and for this reason it ought to be abolished." He might with almost as much reason use the same argument, to have all colliery workings abolished.

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NATIONAL ASSOCIATION OF COLLIERY MANAGERS.

The members of the Lancashire Branch of the above association held their annual gathering at Wigan on Saturday, the 11th inst. The chair was occupied by Mr. Tongue, president of the branch. The routine business of the branch was briefly gone through, and then the secretary (Mr. Mehers), at the request of the president, delivered a short address. He expressed a wish that the men over whom they exercised control would during the ensuing year be preserved from any serious accident whilst following their somewhat risky occupation. As colliery managers it was their duty to continue to do their utmost to protect the workpeople under their care by exercising over them constant and diligent supervision, and at the same time providing them with requisite and suitable material for their safety. In the Wigan district it was a source of consolation to know that death from explosions of gas was now a thing of the past, at least such had been the case for the last two years. Several causes had probably contributed to bring about this desirable and commendable state of things, among them being a better knowledge of the laws of ventilation, an improved safety lamp, the use of roburite and other flameless explosives instead of gunpowder, and last, but not least, the persevering and ceaseless efforts of the inspector of the district in trying to impress upon all underground officials the imperative necessity of keeping their respective districts free from gas, and also by teaching colliery managers, and demonstrating by his coal-dust experiments the special danger of using gunpowder in dusty mines. Not long since the coal-dust theory as the cause of explosions was laughed at by every grade colliery official, from the mining engineer down to the shot-lighter, but now it was universally allowed that it was not wise, many say not safe, to use gunpowder in dusty mines, and if proof was needed of this they had recently a melancholy instance of it in the explosion which lately took place at Blackwell Colliery, in Derbyshire, by which seven men lost their lives. But whilst there was reason for congratulation with regard to explosions, yet little or no progress had been made in reducing the number of fatalities from falls of roof, sides, and coal. But in consequence of the high percentage of deaths from these sources, the inspectors and colliery officials were now paying special attention to the propping of the roof and the spragging of the coal, and there could be no doubt that the next Mines Act would contain special, perhaps stringent, regulations relative to the uniform timbering of mines. With reference to the coal trade during the past twelve months, it was no exaggeration to say that in Lancashire it had been in a most deplorable state. Not only had the pits been working short time, but selling prices had been ruinously low. Gas and railway contracts were taken at prices which in his opinion precluded all hope of realising from them a reasonable profit. Various reasons had been pleaded in justification of the action of Lancashire proprietors in accepting unremunerative prices, but the one on which great stress had been laid was to the effect that in the sliding scale districts wages are from 10 to 15 per cent. lower than where the federation operates. South Wales, Durham, and Northumberland, under the aegis of the sliding scale and with a low working cost, could well afford to sell, and would make a profit at prices which would generally be tantamount to ruin to those outside the sliding scale circle, consequently they had been able to secure the lion's share of the gas and railway contracts, and also the bulk of the coasting and shipping trade. The consequence of this state of things could be seen in the fact that whilst the pits in Lancashire during last summer were only working two or three days a week, those in the sliding scale districts had been spinning away full time. It was to be hoped that this would not be repeated next summer, but that Lancashire would get a proportionate share of the coal trade.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1—Thos. E. Aitchison, Green Hill, Dunaskin, Ayrshire.

Commended—J. Hardman, 44, The Green, Haydock, Lancashire; Thos. Lawrenson, 269, New Boston, Haydock, Lancashire; S. Davies, Barrow Farm, Worsbro., near Barnsley; W. Dickinson, Edwin Street, Amble, by Acklington, Northumberland; Wm. Mitchell, Dalharco, Patna, Ayrshire, N.B.

Question 2—G. Daykin, 24, High Guerney Villa, near Bishop Auckland, Durham.

Commended—S. Davies, Barrow Farm, Worsbro., near Barnsley; J. Stephenson, Wharton Street, Coundon, Bishop Auckland, Durham; Thomas E. Aitchison, Green Hill, Dunaskin, Ayrshire; Jas. Hardman, 44, The Green, Haydock, Lancashire; Thomas Lawrenson, 269, New Boston, Haydock, Lancashire.

Question 3—Sam. Davies, Barrow Farm, Worsbro., near Barnsley.

Commended—Thomas Lawrenson, 269, New Boston, Haydock, Lancashire; Thos. E. Aitchison, Green Hill, Dunaskin, Ayrshire; J. W. McKearn, 11, Tyne Street, Willington, Durham; J. Stephenson, Wharton Street, Coundon, Bp. Auckland, Durham; Wm. Mitchell, Dalharco, Patna, Ayrshire, N.B.

CORRECTION.

In No. 21, Vol. III., page 253, Example V., the question is worked out as if the original airway was 64 square feet area, and the new airway 36 square feet area instead of *vice versa*.

Thomas Banks (Haydock) was successful at the Manchester Examination for first-class certificates, though his name did not appear in the list of successful students first publlshed in the local papers.

ANSWER TO CORRESPONDENT.

CONSTANT READER.—All back numbers can be had by applying to *Mining* Office, or from your local agent. You may have your numbers bound at the following rates :—Leather 2s., Cloth 1/6; Postage 4½d. Thanks for correction. The correct answer to the Geometrical Question will be published next issue.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 6. Vol. IV. February 8th, 1896.

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THE ENGINEERING OF COLLIERIES

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

Assistant M.E.

First-class Certificated Colliery Manager.

(Commenced in No. 9, Vol. III.)

ORIGINAL ABBREVIATED FORMULAE FOR CALCULATIONS OF SIZE OF WINDING ENGINES (continued).

TO more clearly prove the accuracy of the formulae given, and to demonstrate its use and brevity, a possible example will be taken and worked out in the various methods.

Ex.—Required the size of rope, engines, etc., necessary to wind 44 cwt. of coal per wind, with tubs of 11 cwt. capacity, from a depth of 235 yards; effective steam pressure, 64 lbs.; no balance.

(This example has been arranged to work out evenly to simplify the calculations, to render them less confusing, and to more easily show that the results from the three formulae are identical.)

The weight of the tubs will equal about ·4 of the weight of the coal, or $44 \times \cdot 4 = 17 \cdot 6$ cwt.

The cage and chains will weigh about ·6 of the full load, or $(44 + 17 \cdot 6) \times \cdot 6 = 36 \cdot 96$.

The greatest strain on the rope will be the weight of the full cage, or $44 + 17 \cdot 6 + 36 \cdot 96 = 98 \cdot 56$ cwt.

Assuming the safe working load of a rope to be $\frac{1}{10}$ of its breaking strain, a load of 98·56 cwt. would require a rope with a breaking strain of about 50 tons, but as the weight of the 235 yards of rope has to be included in the strain, a rope with a breaking strain of about 56 tons will be required.

The writer's formula for ascertaining the size and weight of rope required is (for best plough steel), divide the breaking strain by $4\frac{1}{2}$, and the result is the weight of the rope in lbs. per fathom. To find the circumference of the rope take the square root of the weight in lbs. per fathom, thus:—

$$56 \div 4\tfrac{1}{2} = 12 \cdot 44 \text{ lbs. per fathom.}$$

$$\sqrt{12 \cdot 44} = 3 \cdot 5 \text{ ins. circum. of rope.}$$

To show the accuracy of this formula reference to the table published by a leading firm of ropemakers gives—3·5-inch rope, 12·5 lbs. per fathom, 56 tons breaking strain, for best plough steel.

The load on the engine is as follows:—

	lbs.
Coal, 44 cwt.....	= 4928
Rope, 235 yds., at 12·5 lbs. per fathom.....	= 1468·75
	6396·75

Say load on engine = 6400 lbs.

Let—

A = Area of cylinder in square inches
S = Stroke of piston in feet
P = Effective steam pressure in lbs.
C = Circumference of drum in feet
L = Load on engine in lbs.

Also let—

d = Diameter of cylinder in inches
D = Diameter of drum in feet

(1) By the ordinary formula it is necessary to assume the stroke of the piston and fix the size of the drum. Assume stroke = 5ft. and diameter of drum 15 feet:—

$$A = \frac{C \times L \times 3}{2S \times P \times 2}$$

$$\therefore A = \frac{15 \times 3 \cdot 1416 \times 6400 \times 3}{10 \times 64 \times 2} = 696 \cdot 86$$

$$A = d^2 \times \cdot 7854$$

$$\therefore d^2 = \frac{696 \cdot 86}{\cdot 7854} = 900$$

$$d = \sqrt{900} = 30 \text{ inches.}$$

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(2) Assuming the length of the piston stroke to be twice the dia. of the cylinder, the writer's formula is:—

$$d = \sqrt[3]{\frac{D \times L \times 18}{P}}$$

$$\therefore d = \sqrt[3]{\frac{15 \times 6400 \times 18}{64}}$$

$$d = \sqrt[3]{27000} = 30 \text{ inches.}$$

(3) Assuming the diameter of the drum to be three times the length of the piston stroke the formula becomes:—

$$d = 3\sqrt{\frac{L}{P}}$$

$$\therefore d = 3\sqrt{\frac{6400}{64}}$$

$$d = 3 \times \sqrt{100} = 30 \text{ inches.}$$

Say stroke 5 feet and drum 15 feet dia.

In addition to being more quickly accomplished, the two last formulae possess the advantage of giving the result at one calculation, whereas by the first method if the assumed stroke of piston is not in a proper proportion to the diameter of the cylinder it is necessary to re-arrange and repeat the calculation. The last formula is still more advantageous, as the piston stroke may be made in any required proportion to the diameter of the cylinder after the calculation has been completed, always assuming, however, that the diameter of the drum is equal to three times the piston stroke.

MINING NOMENCLATURE,

By W. FAIRLEY, Ph.D., F.G.S.,

Author of 'The Colliery Manager's Catechism,' 'The Colliery Manager's Calculator,' 'Theory and Practice of Ventilating Coal Mines,' &c., &c.

(Specially written for "Mining.")

ONE of the most important things in the successful management of any business is the use of correct language, and the ease and facility with which ideas and occurrences are accurately conveyed from one person to another. This applies to no art or business more than it does to that of coal mining.

There is no one who has been accustomed to the management of mines and large bodies of workmen, but will have found at some time in his career, a difficulty in fully comprehending the meaning of a narrative when related by some person comparatively illiterate. The writer has in his experience met with this difficulty frequently—even in England. Hence the necessity of mine officials—subordinate to the management—being not only practical men, but men of intelligence who are gifted with the power of expression.

A very necessary acquisition for correct speaking is a knowledge of the proper meaning of the words made use of.

One of the difficulties in the English literature of mining is that the terminology of each mining district is different, the greatest difference being between that of the coal mines of the British Isles and that of North America.

The differences in the terms used for the same thing in the different districts of Great Britain are sometimes very striking.

A road to the rise—it may be in the gob, or an excavation driven upward in the coal is called in Somersetshire a *topple*, in Gloucestershire a *hatching*, in Lancashire an *upbrow*, in Durham a *rise-board* or *rise-headways*.

A dislocation of strata is called in Durham a *slip*, *hitch* or *trouble*, in Staffordshire a *thing*, in Somersetshire a *trap*; where, when the strata are thrown up it is called a *trap-up*, when down a *trap-down*.

That which is called a *bowk*, a large iron tub, in Staffordshire, is called a *hudge* in Somersetshire, and a *kibble* in Durham and Northumberland.

The next official to the underground manager is called *oversman* in Scotland, *overman* in the North of England coalfield, and *bailiff* in Somersetshire.

The incline road of a mine, up which the mineral is hauled, is called a *dook* in Scotland, an *engine-plane* in Durham, a *down-brow* in Lancashire, a *dukeway* or *gug* in the Bristol and Somerset coalfields, a *slant* in Wales, and a *slope* in the United States.

The argillaceous strata of the coal measures are in the North of England spoken of as *blue-metal*, in Staffordshire *bind*, in Somersetshire *clift*, in Bristol *duns*, in South Wales *cliff*.

An excavation made across the coal measures or in rock is called in Somersetshire a *branch*, in Durham a *stone-drift*, in South Staffordshire a *hard-heading*, in North Staffordshire a *crut*, in the United States and other parts a *tunnel*.

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The old workings in a mine are in some districts indicated by the word *goaf*, in others by *gob*, in Derbyshire by *the old man*, as in Germany *der alte Mann*.

The word *culm* when used in South Wales means the small of anthracite coal, in the United States it means fine coal and dirt or stone.

The operation of undermining a mineral or cutting in at the bottom of or underneath it, is called variously *kirving*, *benching*, or *binching* and *holing*.

The silicious rock of the coal strata is called *post* or *free-stone* in Durham, *sandstone* in Stafforshire, *grays* in Somersetshire, and *quar-cymraeg* in Wales.

The yearly rental under a mineral lease is called variously *dead rent*, *minimum rent*, and *certain rent*.

The man who extracts the coal from a seam or vein is called in Somersetshire a *breaker*, in Bristol a *coal-getter*, in Durham a *hewer*, in Pennsylvania a *miner*.

In Cannock Chase the end of the road going into the face of workings in longwall is frequently called the *back of the head*.

The vehicle in which the mineral is conveyed in or about a mine is called in England generally a *tub*, but sometimes a *tram*, whilst in America it is called a *mine car*.

That which is called a *stenton* or *thirling* in the North of Egland, is called a *break-through* in the United States.

That which is called the *wark-batch* at the collieries of Somersetshire, is called the *rubbish-heap* in Durham, and the *dump* in America.

The *self-acting incline* of England is synonymous with the *gravity plane* of America.

A small transport vehicle in Derbyshire is called a *dan*, in Somersetshire a *put*, and in America a *buggy*.

The operation of surveying a mine by compass is called variously in England *lining*, *latching* and *dialling*.

The use of such a variety of words to designate the same thing is somewhat unaccountable, and must be confusing to the non-technical man in reading mining literature as it is to the practical miner when he moves from one mining district to another. Some of the words do not appear to be appropriate, but so long as they are understood that is the chief thing. The *rice* of Somersetshire is I believe not generally understood by the miners of the greater part of England, but in Scotland the word appears to be known and used in the same sense as in the Radstock coalfield, and has its equivalent in the German *Reis* or *Reisholz*.

Many of the terms strike one as being unscientific, and there does not appear to be any reason why a term, when clearly appropriate, should not be used in all mining districts for designating the same thing.

The differences between the terms used in one district and another, is in some cases to be accounted for in the peculiarities of the mode of occurrence of the mineral and its quality as well as other circumstances, and thus certain of the words become localized. *Culm* is not used or understood in Britain, excepting in the western portion of the South Wales coalfield, because the occurrence of anthracite is limited to that area.

In a few cases the mining terms made use of in America are more appropriate than those used in England for the designation of the same thing. *Dump* I think is better than *rubbish tip*, and *gravity plane* than *self-acting incline*. In other cases this is not so, we do not see that *employee* is better than *workman*, that *fireboss* is better than *fireman*, or that *mine boss* is better than *manager*. *Shipment* as applied to coal sent by rail is inappropriate, and is not so good as the word *vend* used in some parts of England.

The following words used in the United States are unknown about English mines in the sense they are applied there, *battery*, *boss*, *breaker*, *breast*, *buckwheat*, *chesnut coal*, *check-battery*, *chute*, *egg coal*, *gangway*, *gunboat*, *&c.*

The peculiar word *jud*, which is used in the coalfield of Northumberland and Durham has two distinct meanings, and is entirely unknown in many coalfields. If an order should be given by an American mine boss to one of his miners to *sprag his jud*, he would be unable to understand its meaning. This expression is made use of in the special rules now in force in the inspection district of Mr. Thomas Bell, Durham.

In the writer's opinion the mining terminology of Germany is more appropriate and exact than that of England and other countries where the English language is spoken. Take the word *Überhau*, this is universally understood where German is spoken to mean a place worked to the rise, whereas in England we have no specific

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name, but various local names for it; the nearest equivalent to the German being the word *topple—top-hole*—used in Somerset. Then, again, the meaning of the word *Verwerfung* used in Germany to designate a dislocation of strata, is more easily grasped than any of those used for the same thing in England. The expression *das Liegende* is better understood in Germany than the word *thill* in England.

As in all probability the English language is destined to become, within a comparatively short, and almost calculable period of time, the official language of the governments of the various countries of the world; and considering that mining operations are likely to be carried on for ages yet to come, it seems quite worth while to devote some trouble to the improvement of our mining terminology, which at present appears to be very defective. There are many obvious misnomers for which more appropriate terms should be substituted.

The use of appropriate words, and the practice of carefully expressed language has more to do with the successful management of mines than is generally imagined; in fact it is as important to use accurate language in the administrative affairs of colliery management, as it is to use fine machinery in the mechanical operations of the work.

Non-mining readers of technical papers frequently complain of the want of information respecting the meaning of terms used, which very often have only a local application.

If the members of the American Institute of Mining Engineers, and those of the Federated Institution of Mining Engineers were to confer together on this subject, we feel sure that more uniformity in the use of mining terms would be the most probable result, and that the study and practice of this useful and honourable art could be prosecuted on a more scientific basis than is the case at present.

A series of boreholes have recently been put down near Ballycastle (Antrim), and have proved a coalfield of considerable area, containing three seams of coal, 23in., 29in. and 4ft. thick respectively. Overlaying one of the seams is a band of ironstone 4ft. thick. It is now contemplated establishing a small colliery to work the coalfield.

All communications appertaining to the sale of the paper, agents, etc., to be made to the Publishers, Messrs E.Marlborough &Co., 51 Old Bailey, London,EC

ACCIDENTS IN MINES.

To the Editor of the Wigan Observer.

SIR,—How much is a miner's life worth? Some may be inclined to resent such a query, but I maintain that it is the natural attribute of the obstinate, yea, almost criminal action of many colliery managers during the past ten years. When asked why they do not adopt some definite precautionary measures or alter something which would tend to greater safety—What reason do they give? That these will increase the cost of getting, a fraction of a penny a ton, and will reduce the yearly dividend by perhaps one-eighth per cent. What a miserable excuse, forsooth, when so many lives are at stake! Are several hundred lives to be lost annually in this country alone for such a reason as this? Colliery managers, under-managers, and firemen should be compelled to do right even if they have not sufficient conscience to dictate it. From the number of accidents which have been occasioned during the past year, it is evident that the discipline at many pits is not as perfect as the circumstances require. The number of prosecutions by the management under this head are by no means in the proportion we should expect from the accidents caused thereby, for one infringement that has disastrous results, there are many in which the perpetrators escape unscathed. In addition to the large number of fatal accidents which occur annually, there are numerous accidents which although causing injury do not result in death. We may estimate the latter at one hundred to every fatal accident. Some time ago Mr. Brighouse said that the Legislature would have to compel coalowners to adopt a systematic mode of timbering in mines, but why should it need Acts of Parliament to compel coalowners to look to the protection of life and limb? I condemn most emphatically the "cheap Jack system" of working coal pits by contractors or Butty men, for this system is responsible for loss of life, as they push and drive the men who work for them without taking the trouble to timber and make themselves secure, and in many cases have lost their lives in consequence. Prop-drawing has been responsible for loss of life, and for this reason it ought to be abolished. Many lives have been lost by drawing one single prop. It would be interesting to know whether the men who are selected to sit as jurors on inquests on the bodies of men killed in the mine have worked in the mine themselves, for how can they understand the evidence if they have not. I protest against so many verdicts of accidental death being given when the majority of these deaths are preventible. In many mines there are chalk-lines drawn across the roof, signifying that a bar or prop wants setting, and I have seen these chalk marks up for months without any timber being set. When a collier's place falls up it is unsafe for the collier, but the dataller or daywage-man has to make it safe for the collier. I have seen firemen sound the roof with a stick, and call it safe, and as the fireman is the dataller's boss, the dataller must not dispute his authority, nor use his own discretion as to whether the roof is safe or not, even though he may have more intelligence than the fireman, or else he speedily gets the order of the sack. When the results of the meetings of the Firemen's Association used to be published in the *Observer*, I naturally thought they would read a paper on "Accidents in mines, and how to prevent them," but, alas, it never came. In concluding, to reduce the number of these accidents, it is absolutely necessary that stringent measures be

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immediately taken. No half measures are sufficient. Stricter discipline in the mines is necessary; let us have a few more prosecutions by Her Majesty's inspectors, and the number of accidents will decrease.

I am, sir, yours sincerely,

Jan. 18. A DEMOCRATIC PITMAN.

To the Editor of the Wigan Observer.

Dear Sir,—It was with some surprise that I read the correspondence in last week's issue of your paper, headed as above. One-half of the communication is an unaccredited abstract from an article written by me and published in *Mining* in July last; in consequence several persons have intimated that I am the writer of the letter signed "A Democratic Pitman." This I beg to emphatically deny, as I have no desire to have some of his statements attributed to me. I enclose printed copy of my article on "Accidents in Mines and their Prevention," in which my views as to the best practical means of reducing the number of accidents in mines are fully expressed.

Yours sincerely,

J. A. O'DONAHUE,

Wigan, Jan. 20. Editor of *Mining*.

To the Editor of the Wigan Observer.

Sir,—With reference to the letter of Mr. O'Donahue, which appeared in Saturday's *Observer*, in which he states that one-half of my communication is an unaccredited abstract from an article written and published by him in a journal called *Mining*. I hasten to inform Mr. O'Donahue that when the July edition of *Mining* appeared I was over 100 miles distant from Wigan, and working at one of Lord Lonsdale's collieries in Cumberland. I enclose a document which will prove what I say. As for the paper called *Mining* I have never seen it, and I never knew of its existence until now. I know no more about it than the man in the moon, and I repudiate the assertion with the scorn and contempt which it richly deserves. I take it that Mr. O'Donahue published an article on "Accidents in mines and how to prevent them," and as some of my statements coincide with some of his he arrived at the conclusion that they are extracts from his article, a statement which is ridiculous and absurd. Readers of the *Observer* will see that if some person had not intimated that he was the author of the letter signed "A Democratic Pitman," he would never have replied to my letter. In justice to the editor of *Mining*, I beg leave to say that I am the author of the letter which appeared in the *Observer* recently, the italics of that letter, signed "A Democratic Pitman," are mine alone, without the assistance of self-constituted authorities on mining, and for which I accept the fullest responsibility. Being stung with remorse on reading in the *Observer* recently, that men whom I have worked with previously in the mine, and who perished in the mine, my object in writing that letter was to minimise, if possible, the number of accidents by falls of roof and sides which occur in the mine, and if it succeeds in doing so, then the object for which it was written will have been achieved. Being a thorough hater of shams, I intend to out with the truth, however unpleasant it may be to the parties concerned. Thanking you, sir, for so kindly publishing my letters and for laying our case so fully before the public.

I am, yours respectfully,

Feb. 1st. A DEMOCRATIC PITMAN.

Copy of letter forwarded to the Editor of the Wigan Observer.

Sir,—Allow me to commend your correspondent "A Democratic Pitman," for the ingenious manner in which he works up his defence, considering the circumstances, but he has evidently overlooked the possibility of a reply from me. It was from no desire to claim authorship of the extracts made from my article, that I wrote you in the first instance; but to disclaim all knowledge of the portion appended by your correspondent. The extracts are of themselves inconsequential, but as he denies they are extracts, it remains for me to offer proof of my assertion. Enclosed I send a copy of *Mining*, which you will see is dated July 27th, 1895, and I wish you to vouch for the authenticity of the following extracts taken from the article "Accidents in Mines and their Prevention," pages 216 and 217, and from "A Democratic Pitman's" first letter, as published in the *Wigan Observer*:—

(*Extract from "Mining," July 27th*, 1895.)

How much is a miner's life worth? Some may be inclined to resent such a query, but the writer maintains that it is the natural attribute of the obstinate, yea, almost criminal action of many colliery managers during the past ten years. When asked why they do not adopt some more definite precautionary measures, or alter something which would tend to greater safety—What reason do they give? That these will increase the cost of getting, a fraction of a penny a ton, and will reduce the yearly dividend by perhaps one-eight per cent. What a miserable excuse, forsooth, when so many lives are at stake! Are several hundred lives to be lost annually in this country alone for such a reason as this? . . . Colliery managers should be compelled to do right, even if they have not sufficient conscience to dictate it. . . . From the number of accidents which have been occasioned during the year . . . it is evident that the discipline at many *places* is not so perfect as the circumstances require. The number of prosecutions by the management under this head are by no means in the proportion we should expect from the accidents caused thereby, for one infringement that has disastrous results, there are many in which the perpetrators escape unscathed In addition to the large number of fatal accidents which occur annually, there are numerous accidents which although causing injury do not result in death. We may estimate the latter at one hundred to every fatal accident. To reduce the number of accidents it is absolutely necessary that stringent measures be immediately taken. No half measures are sufficient. . . . Stricter discipline in the mines is necessary; let us have a few more prosecutions by *the management*, and the number of accidents will decrease.

(*Extract from "Observer," Jan. 18th*, 1896.)

How much is a miner's life worth? Some may be inclined to resent such a query, but I maintain that it is the natural attribute of the obstinate, yea, almost criminal action of many colliery managers during the past ten years. When asked why they do not adopt some definite precautionary measures or alter something which would tend to greater safety—What reason do they give? That these will increase the cost of getting, a fraction of a penny a ton, and will reduce the yearly dividend by perhaps one-eight per cent. What a miserable excuse, forsooth, when so many lives are at stake! Are several hundred lives to be lost annually in this country alone for such a reason as this? Colliery managers . . should be compelled to do right even if they have not sufficient conscience to dictate it. From the number of accidents which have been occasioned during the past year, it is evident that the discipline at many *pits* is not as perfect as the circumstances require. The number of prosecutions by the management under this head are by no means in the proportion we should expect from the accidents caused thereby, for one infringement that has disastrous results, there are many in which the perpetrators escape unscathed In addition to the large number of fatal accidents which occur annually, there are numerous accidents which although causing injury do not result in death. We may estimate the latter at one hundred to every fatal accident. . . . In concluding, to reduce the number of these accidents, it is absolutely necessary that stringent measures be immediately taken. No half measures are sufficient. Stricter discipline in the mines is necessary; let us have a few more prosecutions by *Her Majesty's Inspectors*, and the number of accidents will decrease.

By comparing the above it will be seen that practically *every word* of the extracts from my article, except the word "management"—for which "Her Majesty's Inspec-

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tors" has been substituted—has been reproduced in his letter, and I hope he will excuse my being too sceptical to believe it is merely a coincidence; however, I cannot see that it was "absurd and ridiculous" to say they were extracts. He misleads your readers entirely by saying he could not have seen *Mining* in July last, because he was in Cumberland, for the simple reason that although *Mining* is printed in Wigan, it is not a local paper, in fact not 5 per cent. of its readers reside in the Wigan district. His argument would not affect the case had he been in Australia instead of in Cumberland, as *Mining* readers are not confined to Great Britain alone. He digresses considerably from the subject in hand to apply the term "self-constituted authorities," and I beg to state that I am no self-constituted authority, inasmuch as I do not claim to be an authority upon any subject, but as editor of a mining journal it is necessary for me to give an opinion. Further, the article on "Accidents in Mines and their Prevention," was read by several thousand mining persons, and although I do not claim —nor did I then—that the whole of my suggestions for minimising the number of accidents are infallible or practical, no one has as yet, to my knowledge, condemned any one of them.

Your correspondent is correct in his conclusion that I would not have written in reference to his letter, had there not been some intimation that I was the writer, as I have something more to do than attend to anonymous correspondence, unless I am personally affected. Had the extracts been published without appendages, with which I disagree, as has been done previously in certain instances, I would not have troubled to claim the authorship, even had there been a name attached to them, instead of a *nom-de-plume*.

I hope this will conclude the correspondence on this matter, but if "A Democratic Pitman" has anything further to say, his first duty is to explain the remarkable *verbatim* similitude of portions of my article published in July last, and his letter written six months later. If he cannot do this, and continues to deal in personalities, I shall ignore any further correspondence from him. Yours sincerely,

T. A. O'DONAHUE.

Wigan, Feb. 4th. Editor of *Mining*.

SOUTH WALES INSTITUTE OF ENGINEERS.

The general meeting of the above Institute of Engineers was held in the Lecture Theatre, Cardiff, on Thursday, the 16th ult., Mr. ARTHUR J. STEVENS, the president, presiding.

THE WESTERN PART OF THE SOUTH WALES COALFIELD.

Mr. THOMAS ARNOLD (Llanelly) made a supplementary statement upon this subject. He had been asked by the institute to extend the sections eastwards as far as the Swansea Valley, to join with existing sections and correlate the coal seams in the district covered by his paper; and he now contributed a first instalment of this work. He expressed a hope that, with the assistance of local gentlemen, who were intimately acquainted with the eastern part of that district, and who had already supplied him with valuable information, he might be able by the next meeting to lay before them further plans and sections which would go some way to carry out the above idea. In the meantime, he had extended longitudinal section No. 2 from Garngoch to the eastward, through the Redhead Colliery and the Worcester Colliery to the Weig Fawr Colliery, near Swansea. By reference to this section, they might now identify and correlate the seams in the Upper Pennant series from Llanelly to Swansea.

Mr. HORT. HUXHAM said he was very much interested in the remarks made by Mr. H. K. Jordan, at the last meeting, upon the changing character of the quatity of the coal from south to north and from east to west. This had been a disputable point for many years. It had been brought before the institute on several occasions, and no definite conclusion arrived at. He could not say he agreed with Mr. Jordan's conclusion—that the change of quality had arisen from difference in the carboniferous flora forming the carbonaceous deposit of the same seam in different areas. The change was of a very gradual character both from north to south and from east to west, and also from the deeper coals to the higher coals in the coalfield. For his part he did not think the change was attributable to a heat anything approaching that which would discolour the shales or change the character of the limestone as suggested by Mr. Jordan. He would throw out the suggestion—which, however, was not a new one—whether the change might not be attributable to heat produced by the coal measures, which had been affected anthracitically, having been depressed prior to denudation to a very much greater extent than those that were of a bituminous character—that they had been subjected to a very much greater pressure and resultant heat. He thought it only required a comparatively low temperature—from 100 to 200 degs. Fahr.—to produce the change if given sufficient time. He was rather inclined to believe that the change had come about by an immense pressure, with quiet heat, extending over a vastly prolonged period of time.

Mr. J. K. JORDAN thought Mr. Arnold could get the information for correlating the seams by going into the Neath district, where he would find the Hughes seam being worked. There could be no doubt that the seam worked at the Eaglesbush Colliery, near Neath, was the Hughes seam. With regard to the

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change in the character of coal, he was careful at the last meeting to simply throw out as a line of investigation the theory that the change from bituminous to anthracite was due to the difference in the character of the plants of which the coal was constituted; he did not commit himself to it. As to Mr. Huxham's suggestion that the change might be due to the enormous pressure which the anthracite coals must have been subjected to, he would remind him that in this very district they had the thickest strata in the coalfield of South Wales, and they found that the deepest coals—which therefore must have been subjected to the greatest pressure—were of a bituminous character.

DISTRIBUTION OF POWER IN COLLIERIES.

Discussion was resumed upon the paper on the above subject, written by Mr. LL. B. ATKINSON.—In supplementing his paper, Mr. Atkinson quoted from the report of the directors of Messrs. Dorman, Long and Co., Middlesborough, rollers of steel and makers of joists and builders' sections, &c. The case, he said, was not absolutely identical with a colliery, but it was not unlike. The works covered a large extent of ground, for which the power had been distributed by taking steam pipes to various engines all over the works, and also by independent boilers at various points. In the early part of 1894, the company commenced to lay down an electrical plant for generating power at one site and distributing it where wanted, and doing away with the outlying engines and boilers. In their report the directors of the company made the following remarks:—"The saving effected by the expenditure during 1894 in applying electrical power to the outlying machinery was found to be so satisfactory, that your directors felt justified in a further outlay in this direction, and hence the greater part of the capital expenditure this year in electrical machinery. Up to the present time the total amount spent on this head is about £8,000, and the saving is at the rate of £3,000 to £4,000 a year, in addition to increased efficiency." Here was the practical application of principles, suggested in his paper for application to collieries, to a somewhat analogous industry, with the result of a saving of half the capital outlay in the first year, in addition to increased efficiency. He deemed this a remarkable practical proof of the correctness of the principles he advocated, and one that would appeal to commercial men.

Mr. W. D. WIGHT thought the great danger arising from electrical power in fiery mines was that of sparking. Then there was the question of cost. Not long ago, he saw one of the most modern electrical plants that had been put down in the South Wales district, used both for haulage and pumping, and he was given to understand that although the total horse-power was only about 100, the plant cost between £7,000 and £8,000. As to the case cited by Mr. Atkinson in the North of England, the statement required a good deal of explanation before it could be accepted. How was the saving affected? In fuel alone, or in fuel and labour? Was it affected by putting electricity to do work that had been previously been done by hand? As regarded the use of compressed air as a means of distributing power underground, he was firmly of opinion that compressed air had never yet had a fair chance. He believed it was quite possible to have air-compressors which would give a very much higher duty than any that had yet been made. If as much money were spent upon improving air-compressors as upon electricity, they would not be far behind in efficiency. They all acknowledged the convenience of compressed air underground, and if it approached electricity in the percentage of efficiency, they would much prefer it because of that convenience. Then he did not think the motors they had been using in connection with compressed air had ever been designed for the purpose. They had been using steam engine motors, whereas compressed air motors ought to be designed upon different lines with a view to a greater utilisation of the air than was now the case.

Mr. T. H. BAILEY said his experience of both powers showed him that there was no question; electricity was the easiest of manipulation by far; and if it were not for the uncertainty with regard to safety in fiery mines, he thought it would be universally adopted.

Mr. SYDNEY F. WALKER gave an interesting disquisition upon electrical phenomena. Referring to the recent experiments by a professor at Vienna, which it was believed would revolutionise photography, he said the results looked very mysterious until we came to enquire what was the source of light. Then we found it was not a source of light at all, but a series of electro-magnetic waves which had been sent down. The source of light was a vacuum tube with a series of electric currents passing through, and generating light in their course. Of course, he viewed electricity as one thing and electro-magnetism as quite another, being as distinctive as heat, light and sound.

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Mr. Ll. B. Atkinson said the real object of writing his paper was not so much to again introduce the subject of electricity *versus* compressed air as a means of transmitting power, as to raise the question of generating all the power at one point and transmitting it, by some means or other, to the places where it was required. Except in the remarks of the president at the last meeting, that point had not been largely dealt with. Mr. Wight had spoken of a 100-horse power electrical plant costing £7,000. He (Mr. Atkinson) was at a loss to understand how such a figure could be arrived at. He should say that less than half that amount would be the ordinary market price for generators, engines, motors, pumps, &c., of that power. He was recently associated with an electrical plant transmitting nearly 300-horse power a distance of over 10 miles, and the total cost was only £10,000, carried out in South Africa, where, of course, wages and cost of transport were heavy.

Hydraulic Pumping Plant.

Mr. James Barrow, author of a paper upon the Moore hydraulic pumping plant he has put down, said he was having experiments made in order to arrive at the exact powers which had been given out by the hydraulic compound engines. The conditions were somewhat peculiar in that the lower length was something like 800 or more yards from the surface down to the lower set of pumps; and they found in that distance the natural compression of a column of water of about 2,700 or 2,800 feet long was about 10 inches. That was to say, with the ram travelling 4 feet, the lower pump would travel 3 feet 2 inches; and up to this time they had not been able to get a longer stroke out of that lower pump. Whether this was brought about by friction in the column of pipes of that length, or whether it was the compression of the water, having regard to the perpendicular height—534 yards, or nearly 1,600 feet—and allowing for the air that must of necessity be in that length of water, he did not know, but he was anxious to arrive at what the loss would be as between the engines and the pumps in that position. Later on he should get the actual results, showing the quantity of water they were lifting per pound of coal consumed on the boilers. These boilers had 100 lbs. working pressure, which was taken at that pressure into the higher pressure cylinder, and compounded and condensed.

ANSWERS TO COMPETITION QUESTIONS

In No. 3, Vol. IV.

MECHANICS.

(1) What is the pressure of steam per square inch in a boiler, the whole length of the safety valve lever being 32 inches, distance between the fulcrum and the valve 4 inches, diameter of valve 2½ inches, and a weight of 300⅝ lbs. placed at the end of the lever?

Answer.—This represents a lever of the 3rd kind; the steam pressing on the valve is the power, which acts between the fulcrum and the weight. In all cases of levers, power × leverage of power = weight × leverage of weight. In this case we have weight = 300⅝ lbs., leverage of weight = 32 inches, leverage of power = 4 inches, *i.e.*, the distance between the fulcrum and the valve.

The area of the valve =

$$2{\cdot}5^2 \times {\cdot}7854 = 4{\cdot}90875 \text{ sq. ins.}$$

The downward pressure on the valve acting against the steam pressure =

$$300\tfrac{5}{8} \times 32 = 9620 \text{ lbs.}$$

Now this divided by the leverage of power will equal the total pressure on the valve, which becomes—

$$9620 \div 4 = 2405 \text{ lbs.}$$

As there are 4·90875 square inches in the section of the valve, the pressure per square inch will be—

$$2405 \div 4{\cdot}90875 = 489{\cdot}94 \text{ lbs.}$$

which is the pressure per square inch in the boiler, disregarding the weight of the lever and the valve. Or the pressure per square inch may be found as follows:—

$$\frac{300\frac{5}{8} \times 32}{4 \times 2{\cdot}5^2 \times {\cdot}7854} = \frac{9620}{19{\cdot}635} = 489{\cdot}94 \text{ lbs.}$$

This is an enormous pressure, but the weight on the lever is great, which pressure would be less as the weight becomes less.

Thomas Hill.

WINDING ARRANGEMENTS.

(2) In a winding shaft with cages running on weighted iron conductors you have to wind coal to a limited extent from a mine half-way down the shaft:—Describe and sketch the arrangements you would provide at such mine to allow the winding to be done without risk of accident.

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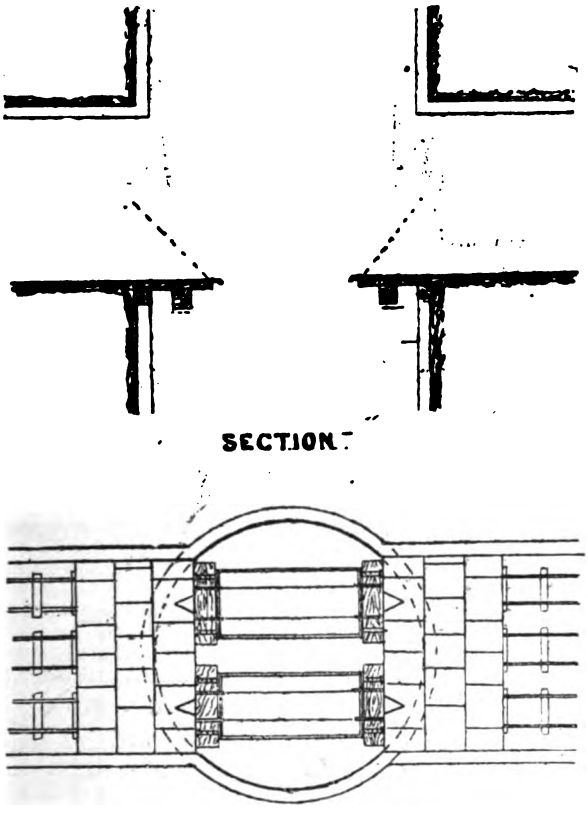


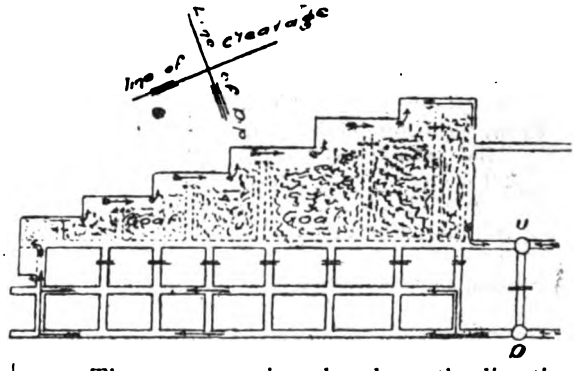
Answer.—I would fix a strong bearer of oak, 18 inches square, on each side, about 12 or 15 inches from the travel of the cage, and a 12-inch piece parallel to this on the edge of the brickwork, and lay 4-inch planks from bearer to bearer, and cover these with landing plates. I would have flaps or wings on each side of the pit (if hooking on at both sides), which are bolted to the bearers with strong wrought-iron hinges. The wings may be made of 3-inch timber, and will be provided with two hooks to catch in the cage to prevent oscillation whilst changing the tubs. When the cage is ready to start away the wings are lifted up by means of a chain and are thus taken out of the way in case it is required to wind from a lower landing. The C.M.R.A. requires that such mouthings shall be fenced off. This is best done by lightly constructed iron gates working in slides and counter-balanced by weights.

JAMES PILKINGTON.

LONGWALL WORK IN MAIDEN GROUND. VENTILATION OF SAME.

(3) Sketch a plan showing how you would open a piece of longwall work in maiden ground, marking the direction of dip and slips, and show by arrows how you would ventilate the workings.

Answer.—In opening out a piece of coal by the longwall method in maiden ground I would commence as shown on plan and drive two levels a sufficient distance from the shaft to leave pillars and room for landing, etc. I would then drive a narrow place at right angles to the level, for about 15 to 20 yards, and open out in longwall, known as step-work. This I would continue for a short time, until I gained experience of the nature of the coal and roof. If the coal was moderately hard and required extra labour for cutting I would work the coal face in a straight line or thereabouts, so as to make the work easier, as the weight would help the miners in getting the coal down along the faces. After having driven the roads through the gob, as shown on plan, I would commence at the third gate and set cross-gates right and left, at different distances, not two roads opposite but equal distance apart, at an angle of 45°, to cut off the older gates and at the same time reducing the length of roads, which always need repairing, and also the length of rails, thus making better exit for the coal.



The accompanying plan shows the direction of air-current by means of arrows; also line of dip and cleavage. The line of cleavage may be altered a little if the nature of the coal and roof is known, but where the nature of the coal and roof is unknown it is advisable to cross the cleavage a little with packs and roads, thus the roof is much better supported and large blocks of stone are not so liable to fall into the roadway along the coal face.

HERBERT HALL.

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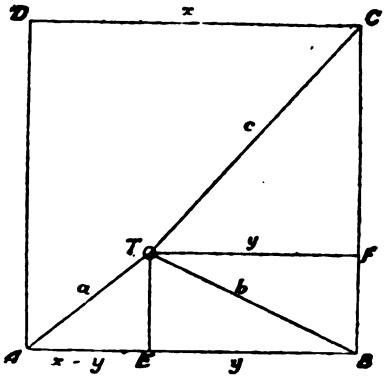
CORRESPONDENCE.

GEOMETRICAL PROBLEM.

When we offered awards for the two best solutions of the geometrical question, given by "Puzzled," we were aware that an accurate answer could be obtained by calculation and an approximate one by plotting to a scale. Although a considerable number of solutions were received only two have sent in the correct answer as arrived at by calculation. To these we award 3/- each, and to the sender of the best approximate solution we award 2/6. Several answers were received too late to be considered.



[BY CALCULATION.]

Let $A\ B\ C\ D$ represent the sq. field and T the tree.

Let $a\,b\,c$ represent $A\,T$, $B\,T$, $C\,T$.
$y = E\,B$ and $x =$ the side $A\,B$.

From the triangle $A\,B\,T$ we get:

$$a^2 - (x-y)^2 = b^2 - y^2$$
$$= a^2 - x^2 + 2xy - y^2 = b^2 - y^2$$
$$= y = \frac{b^2 - a^2 + x^2}{2x}$$

From the triangle $B\,C\,T$ we get:

$$\sqrt{(b^2-y^2)} + \sqrt{(c^2-y^2)} = x$$

Solving this for y we get:

$$y^2 = \tfrac{1}{2}(b^2+c^2) - \frac{x^2}{4} - \frac{(b^2-c^2)^2}{4x^2}$$

Equating these values of y we get:

$$\frac{x^4 + 2x^2(b^2-a^2) + (b^2-a^2)^2}{4x^2}$$
$$= \tfrac{1}{2}(b^2+c^2) - \frac{x^2}{4} - \frac{(b^2-c^2)^2}{4x^2}$$
$$= x^4 + 2x^2(b^2-a^2) + (b^2-a^2)^2$$
$$= 2x^2(b^2+c^2) - x^4 - (b^2-c^2)^2$$
$$= x^4 - (a^2+c^2)x^2$$
$$= b^2(a^2+c^2) - \frac{(a^4+c^4)}{2} - b^4$$

Completing the squares and solving for x^2 we get:

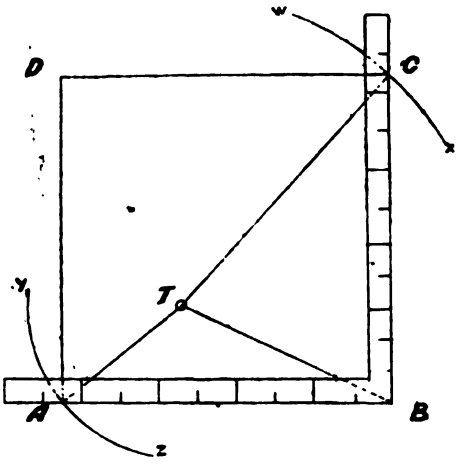
$$x^2 = \tfrac{1}{2}(a^2+c^2) \pm \sqrt{\left\{ b^2(a^2+c^2) - \frac{(a^2-c^2)}{4} - b^4 \right\}}$$

$\therefore$ The plus sign gives the area of field when the tree is in the field, and the negative sign gives it when it is without the field. In our case the tree is in the field, so we will have to take the positive sign.

$$x^2 = \tfrac{1}{2}(a^2+c^2) + \sqrt{\left\{ b^2(a^2+c^2) - \frac{(a^2-c^2)^2}{4} - b^4 \right\}}$$
$$= x^2 = \tfrac{1}{2}(200^2 + 4000^2)$$
$$+ \sqrt{\left\{ 300^2(200^2+400^2) - \frac{(200^2-400)^2}{4} - 300^4 \right\}}$$
$$= x^2 = 100000 + \sqrt{(18000000000 - 3600000000)}$$
$$- (8100000000) = x^2 = \sqrt{\text{result}}$$
and $x = 423{\cdot}52$ side of field.

The above formula is a rule for all similar questions.—THOMAS BRUCE, 32, Dene Row, Bates' Cottages, East Holywell, Newcastle-on-Tyne.

(Somewhat similar answer sent by J. BICKERTON, 44, Holly Street, Newcastle-on-Tyne.)



[APPROXIMATE ANSWER BY PLOTTING.]

Take any line TB and with a suitable scale measure off 300 yards. Let $TB = 300$. With a centre T and a radius = 400 yards on the scale describe an arc wx, and with the same centre and a radius of 200 yards on the scale describe an arc yz. Now take a set square, the sides of which are graduated to a scale (a rectangular piece of paper may be employed), and place its corner on B. Then move the set square about, keeping its corner on B until the points (A C) at which it cuts the arcs are equidistant from B, as seen by the graduations. AB and BC will then be two sides of the square, and the length of either may be ascertained by measuring with the scale. If the scale adopted be about 100 yards to an inch, and care be taken in plotting, the length of the side could be measured to within half-a-yard.—ED.

(Solution sent by J. N. WARDELL, 98, Maxwell St., South Shields, was similar to above.)

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Sir,—Would some of your readers of *Mining* answer me the two following questions:—

CONSTRUCTION OF AIR-CROSSING.

How would you construct an air-crossing to resist the force of an explosion?

VENTILATING SINKING PIT.

How would you ventilate a sinking pit where fire-damp is given off freely from the strata?

Answers to the above would be esteemed a favour.

TYRO.

Sir,—Would you or some of your correspondents inform me through your valuable paper, *Mining*, how to obtain the R.S.M. and N.S.S., also R.C. Science Certificates. An answer will oblige. ANXIOUS.

AN ADDRESS WANTED.

Sir,—Would Mr. W. H. Mungall, or any other reader, be so kind as to forward to the Editor of *Mining* the name and address of the Under-Manager, Newbattle Colliery, near Edinburgh, owned by the Lothian Coal Co., Ltd. By so doing, a regular reader would be greatly assisted and obliged. ANXIOUS.

[Apply to the colliery.—ED.]

Sir,—I would be much obliged for an answer to the following:—(1) Can a person who has a 2nd Class Certificate (advanced stage) sit in the Elementary Stage if he chooses at the next S. & A. Examination? (2) He not being at a Science School, who should he apply to, and would there be any fee? ANXIOUS.

[If you have obtained a 2nd Advanced by all means try for a 1st., and do not contemplate making a retrograde march. Apply to the Sec. of the nearest Science School. You may be required to pay 2/6. We would be obliged if correspondents would adopt more definite *nom-de-plumes* than "Anxious," "Constant Reader," etc.—ED.]

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Thomas Hill, Crosby Villa, *by* Maryport, West Cumberland.

Commended.—A. Eloe, jun., 3, Lime St., Dukinfield, Cheshire; A. H. Meakin, Mansfield Rd., Eastwood, Notts; C. E. Scotney, 44, Byrom Street, Hucknall-Torkard, Notts; R. Renton, Rending St., White Lee, Batley, Yorkshire; R. W. Hall, 2, North St., Murton Colliery, Sunderland; J. Eagleshaw, Stuart's Place, Dalry, Ayrshire, Scotland; J. Nisbit, Crawick Mill, Sanguhua, N.B.; W. Musgrove, Winning Newburn, R.S.O., Northumberland; W. Ollerenshaw, 46, Grosvenor Street, Ashton-under-Lyne; W. Burt, Hayfield Cottage, Pains, Airdrie, Lanarkshire, N.B.; Thos. Watson, 3, East Hedley Hope, Tow Law; W. Mycock, New Silksworth, *via* Sunderland, Co. Durham; J. E. Keefe, Amble, Northumberland; Thomas Lawrenson, 269, New Boston, Haydock, Lancs.; W. Innes, Mason's Land, Chapel Hill, *by* Airdrie; J. Laverick, Butterknowle, County Durham; J. Pilkington, Brancker Street, Chequerbent, near Bolton; W. P. Laws, 28, Pilgrim Street, Murton Colliery; W. H. Hardy, Green Hills, Eastwood, Notts; W. Mitchell, Durham Villa, *by* Maryport, West Cumberland; A. Ratcliffe, 16, Callow Hall Street, Oswaldtwistle.

Question 2.—J. Pilkington, Brancker St., Chequerbent, near Bolton.

Commended.—Thos. Lawrenson, 269, New Boston, Haydock, Lancashire; J. Stephenson, Wharton Street, Coundon, Bishop Auckland, Durham; A. H. Meakin, Mansfield Road, Eastwood, Notts; Herbert Hall, 15, Yardley Terrace, Ryhill, near Wakefield; W. Ollerenshaw, 46, Grosvenor St., Ashton-under-Lyne; Sam. Davies, Barrow Farm, Worsbro., near Barnsley.

Question 3.—Herbert Hall, 15, Yardley Terrace, Ryhill, near Wakefield.

Commended.—Sam. Davies, Barrow Farm, Worsbro., near Barnsley; F. G. Brown, Murton Colliery, County Durham; Thos. Watson, 3, East Hedley Hope, Tow Law.

ANSWER TO CORRESPONDENT.

SURVEYOR.—Shall be pleased to publish the matter you mention.

COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before February 21st, 1896.

We invite readers to forward questions for this competition.

(1) Give description of the kind and size of ventilating fan you would erect to produce 200,000 cubic feet of air per minute, and the size of engine to drive it, &c. Effective steam pressure 30 lbs.

(2) How much more resistance does an air-current encounter when travelling at 600 feet per minute, then at 500 feet per minute. Size of airway being unchanged. If the W.G. is 0·76 at the lower velocity, what would it be at the higher?

(3) Give a brief description with sketch or sketches of what you consider to be a good arrangement of surface works for a colliery with two shafts, fitted to wind 2,000 tons per day. (Award doubled for answer to this question.)

CHANGE OF ADDRESS. The Tredegar Iron and Coal Company, Ltd., proprietors and shippers of the Tredegar "Smokeless" Welsh Steam Coal, have removed their London offices from 28, Queen Street, Cheapside, to *7, Fenchurch Avenue, E.C.*

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EDITORIAL NOTES.

The following is one of the principal clauses in the new Belgian regulations as to the use of explosives in collieries :—"Without previous authorisation the use of explosives is absolutely forbidden in all fiery mines—(1) for bringing down the coal; (2) for workings in coal with descending ventilation in the case of all airways, and for the headings immediately preceding them for a length to be fixed (if necessary) by the Government Inspector; (3) in all workings when it may be presumed that they are approaching old workings, a coal seam, or any excavation in which firedamp can accumulate; and (4) for clearing passes or bing-holes."

* * *

The following note is extracted from the *Iron and Coal Trades Review* :—"An important feature of the coal industry, as now carried on in this country and in most European countries as well, is the larger outputs that are being obtained from a given plant. One or two examples may now be cited: 1,298 tons of coal have been raised in 8½ hours, from a depth of 280 yards, at Plas Power Colliery, near Wrexham. The Derbyshire, Notts, and Yorkshire Collieries often raise from 1,500 to 1,700 tons in 8½ hours, from a greater depth than 280 yards. At Bolsover Colliery, in North Derbyshire, 1,892 tons 6 cwt. of coal have been drawn in 8½ hours, from a depth of 370 yards. Four tubs are raised at one time on two decks, and the total time of the winding, loading and unloading of the cages, averages 37·9 seconds throughout the day; average runs per hour 95·1; average weight of coal per tub 11·31 cwt. The decks of the cage are changed simultaneously above and below ground. The winding engines consist of a pair of 32-inch cylinders, with a stroke of 6 feet. The drum is slightly conical, rising from 17 feet diameter to 18 feet 6 inches diameter. The engines are capable of winding more than the quantity given in the above instance, as 100 runs per hour are frequently recorded. It is well to put these facts on record, inasmuch as they indicate that our colliery practice is fully up-to-date.

* * *

The recent explosion resulting in the loss of some fifty-seven lives, at the Ferndale Collieries, Tylorstown, South Wales, is a too poignant reminder that serious explosions still continue to occur. It was a most fortunate circumstance that the bulk of the workmen were out of the pit at the time, or the number of deaths might have been increased tenfold. This is probably due to the very excellent custom now prevalent in most fiery mines, of firing shots, only when the bulk of the men are out of the pit, though this is only surmise, the cause of the explosion not yet being ascertained. As in previous explosions it is the after-damp that has created the greatest destruction, and there is much difference of opinion at the present time as to which of the gases contained in the after-damp the deaths are principally due. Dr. Haldane has for some time past endeavoured to prove his theory that carbon mon-oxide, is the gas which causes such dire results. He attempted to trace carbon mon-oxide poisoning in the blood of some of the dead horses found in the Albion explosion, but failed to do so, and he is now continuing his experiments with tame mice and some of the dead horses found in this recent explosion. Mr. James Ashworth a short time ago suggested that the fatal gases are oxides of nitrogen, and others conclude that it is carbonic acid gas. Lamps were fonnd burning at the Ferndale Colliery in proximity to a number of dead bodies. This may be accounted for by the different position of the lamps and the men, the gases not affecting the former owing to their specific gravity, or it may indicate the presence of carbon mon-oxide, as lights will continue to burn in an atmosphere containing a much greater percentage of this gas than is necessary to poison human beings.

THE AIR OF COAL MINES.

Dr. Frank Clowes delivered a lecture on the above subject at the University College, Nottingham, on the 25th Jan. In the course of his lecture he said fresh, unpolluted air, when freed from moisture, contains on the average about 21 % of oxygen, 79 % of nitrogen, and 0·04 % of carbonic acid. Some of the most common causes affecting the suitability of air for supporting life are :—(1) The reduction of the proportion of oxygen below 10 %; (2) the increase of the carbonic acid to 10 %; (3) the presence of even 0·2 % of carbonic oxide. It is well known that the process of breathing and burning tend to reduce the proportion of oxygen, and to increase the proportion of carbonic acid in the air. The oxygen is reduced to about 16 % and the carbonic acid is increased to over 3 % by these processes. Air thus changed extinguishes a candle flame, but it can be breathed without serious effect upon the health. Air which has been rendered first extinctive of flame by addition of nitrogen is also respirable. If, however, air is rendered first extinctive by the addition of carbonic acid, it becomes wholly unfit for respiration owing to the presence in it of 14% of carbonic acid. This proportion of the gas quickly produces unconsciousness and is ultimately fatal. Numerous instances are on record of quickly fatal results ensuing from breathing the air of a well or shaft into which carbonic acid from the soil has passed in some quantity. There might be two atmospheres both extinctive of flame, whilst one was a safe atmosphere and the other extremely dangerous. There is another reason why the test by flame must not be too implicitly relied upon. There are many sources from which carbonic oxide may escape into the air. The action of this extremely poisonous gas is more rapid during exertion than repose. The utter loss of power occasioned by carbonic oxide manifests itself in a mouse with about twenty times the rapidity with which it is felt in man. Hence Dr. Haldane has suggested that a mouse might be carried into a doubtful atmosphere; if it becomes powerless, a man will still have time to withdraw in safety. The effect of the atmosphere on flame is quite untrustworthy in presence of carbonic oxide and of very questionable value.

We are continually receiving letters from our numerous readers complaining of their inability to obtain our paper until several days after publication, and wish to remind them that we are doing our best to arrange for all to be supplied at the proper time. Should any of them in future have any inconvenience we should be obliged if they would send on the name and address of the agent who supplies them, with the day on which the paper was received, and we will inquire into the cause of the delay and prevent a recurrence of same if possible. Readers in whatever part of the country they may reside, should be able to obtain our paper by Saturday morning at latest.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 7, Vol. IV. Feb. 22nd, 1896.

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ACCIDENTS IN MINES.

THE records of another disastrous year are again before us; 1,033 lives having been sacrificed to the mining industry in the United Kingdom alone during the year 1895. Apparently the yearly tribute of over one thousand lives must be paid to enable us to develope the mineral resources of the country. It has been unanimously agreed by the mining community that the Mines' Act could be amended with advantage, and the present Government have expressed their intention to deal with the matter, so that we may expect a more beneficial arrangement in a—well! it would be unfair to lay ourselves open to criticism by being too definite as to the period of time which will be required to affect it. Though unanimous in the desire for amendments there is, as may be expected, considerable difference of opinion as to their precise nature. The persons who have a "say" in the matter may be divided into three classes: (1) The mines' inspectors, whose chief aim is safety; (2) The mine owners, who are prepared to accede to any proposed measures for the diminution of accidents, providing it costs them nothing and does not harass them too much with the presence of the mines' inspectors; and (3) The miners' representatives, who are also on the side of safety, but are unwilling to increase the individual labour of the miner without a corresponding increase of wages. The two latter parties must obviously be prejudiced, and it is to the first-named that we must look for reasonable and practical solutions of the various difficulties that have arisen. The number of lives lost by falls of roof and sides is usually about 40 per cent. of the total deaths, and consequently this is one of the principal items of consideration. "Definite timbering" has for some time past been advocated as the best possible means of reducing the number of accidents from those causes, but a specific definite rule would not apply to all classes of mines with good and bad roofs, and recognising this, the rule unanimously recommended by the mines' inspectors for adoption throughout the kingdom and to be enforced by legislation is "Every certificated colliery manager of a mine shall specify the maximum distance that props or supports may be fixed in every coal seam under his charge." In our opinion this covers the whole matter, and as it is working satisfactorily at a large number of collieries where it has been tried, has much to recommend it. Another serious subject for consideration is the number of deaths caused by explosion of firedamp and coaldust. Statistics prove that from 1872 to 1893, that is in 20 years, nearly 3,500 deaths were attributable to the use of gunpowder and naked lights. The total abolition of gunpowder has for some time past been a much controverted proposal, but we do not see how it can be contested for any considerable length of time with the ever-increasing evidence and public prejudice against its use Naked lights, and more especially mixed lights, are an abomination, and the law affecting these should certainly be amended. More than half of the 3,500 deaths, quoted above, were caused by their use. At the recent miners' conference the C. M. R. A. Amendment Bill was much discussed, and the principal subjects upon which resolutions were passed, as requiring amendment, and the proposed nature of the amendments, are briefly as follows:—(1) The prohibition of female labour; (2) More efficient inspection of mines; and (3) The sinking of additional shafts when the workings have extended more than a mile. With the second of these we are certainly in favour. In Belgium the workings of every mine must be inspected and reported upon at least twice a year, and such a rule would with advantage apply to this country. Of course, it would be necessary to increase the staff of mines' inspectors, as this body is already overworked. The third proposal is in our opinion unreasonable, and is not likely to come into force. Colliery proprietors will not readily submit to such a restriction. It is doubtful if the good which would probably result from the prohibition of female labour would outweigh the serious disadvantages attending it. However, we can only hope that the proposed consideration by the Government will result in some of the much required amendments, and, subsequently, in reducing the number of accidents.

* * *

The journal of the British Society of Mining Students for January is exceptionally interesting. The contents are as follows:—"The Lothian Coalfield," by W. H. Mungall, B.Sc.; "The Armiston Collieries, Midlothian," by J. M. Thomson; "An Instance of Tunnelling with Machine Rock Drills," by H. F. Bulman; and "A Summary of Mr. R. M. Haseltine's Experiments with Coal-cutting Machines," also by H. F. Bulman. We purpose giving our readers particulars of some of the above papers in a future issue.

* * *

At a meeting of the Institute of Civil Engineers, held at Westminster, on the 11th inst., a paper was read on "The Manufacture of Aluminum by Electrolysis, and the Plant at Niagara for its Extraction," by Mr. Alf. E. Hunt, M.I.C.E. This paper was to be further discussed at a meeting held on the 18th inst.

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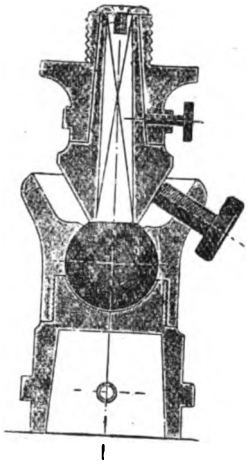
A NEW LEVELLING JOINT FOR SURVEYING INSTRUMENTS.

THE accompanying illustration represents a new form of ball and socket joint intended to do away with the present clamping arrangement for dials, and to take the place of the parallel plate arrangement in the theodolite and level.



The invention is very practical and has been handled by the writer. The illustration explains the principle. There are three adjusting screws, only one of which is shown, which pass through the metal forming the socket (the socket being widened out to the shape of an inverted cone), and converge on to a similar cone which is attached to the ball; by tightening or slackening these screws the top of the joint, to which the instrument is attached, may be thrown to any reasonable angle and may be levelled perfectly.

In other respects the joint is exactly the same as the one commonly used with the miner's dial.

The advantages of the new design are apparent, the instrument needs no clamping arrangement, if the screws are all tight it is perfectly rigid.

In the joints used at present the mere operation of clamping is often sufficient to upset the adjustment of the instrument.

The new joint seems to be a good thing, it is very easily and rapidly operated, and should rapidly make its way to the front.

EXAMINATION QUESTIONS,

WITH ANSWERS BY

J. CARTER, First-Class Certificated Manager.

Questions given in the South-Western District, Sept., 1894, for Managers' Certificates of Competency.

(The figures in parenthesis show the number of marks obtainable.)

(Continued from No. 5, Vol. IV.)

No. 4 Subject.

PRACTICAL MINING & GEOLOGY.

(100 marks to qualify.)

QUESTION 7.—Describe the properties of Anthracite, Bituminous, Semi-Bituminous, Cannel coal, and Lignite. (20)

ANSWER.—Anthracite burns without smoke or flame and is not so easily kindled as other coals, although when in a state of combustion it gives off great heat. Its chief uses are in the generation of steam, manufacture of zinc, and for lime and brick kilns; specific gravity 1·4. Does not soil the fingers when handled. Its fracture is conchoidal, and its composition consists chiefly of carbon, from 90 to 95 per cent.; hydrogen, oxygen, and nitrogen in minute quantities.

Bituminous coal is of two varieties, viz., coking and non-coking. It is valuable as a household coal and for steam purposes. It soils the fingers when handled, breaks with a cuboidal fracture, is usually of a dull colour, and has a specific gravity of 1·26. Its composition is 83 per cent. carbon, 6 per cent. oxygen, 5 per cent. hydrogen, 2 per cent. nitrogen, and 4 per cent. ash.

Semi-Bituminous is of a dull black colour, breaks with a cuboidal fracture, is valuable for steam purposes, and is easily recognised by the flakes of feldspar found in its cleat. Its composition is 80 per cent. carbon, 5 per cent. hydrogen, 11 per cent. oxygen, 1 per cent. sulphur, and 3 per cent. ash.

Cannel coal is a mineral of a black brownish colour, dull lustre, very hard and compact, fracture conchoidal, and does not soil the fingers. It is used very much for making gas for illuminating purposes. It burns freely and quickly and is readily kindled. Its composition is on an average about 80 per cent. carbon, 6 per cent. hydrogen, 7 per cent. oxygen, 2 per cent. nitrogen, 3 per cent. ash.

Lignite is bituminised wood, that is, in a middle stage between wood and coal. It burns usually with much smoke and flame and with an unpleasant odour. Its composition varies from 50 to 70 per cent. carbon, has more oxygen, but similar proportions of hydrogen and nitrogen to the bituminous coals.

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QUESTION 8.—Describe in their order the sub-divisions of the Carboniferous system and their chief characteristics in Gt. Britain. (20)

ANSWER.—The sub-divisions of the Carboniferous system in Great Britain are in the following order proceeding upwards:—

1st. Carboniferous Limestone.
2nd. Yoredales.
3rd. Millstone Grit.
4th. Coal Measures.

The Carboniferous Limestone is formed mainly of shells of mollusca, corals, and encrinites, and contains veins of galena or lead sulphite, which are largely worked in this country.

The Yoredales are comprised of shales and sandstones, and as they reach the North of England and Scotland they gradually become carbonaceous and are finally represented by seams of coal and a few beds of ironstone.

Millstone Grit is formed of grit and shale and poor coal at intervals, and makes a good building material for rough and heavy work.

Coal Measures are of great commercial importance because of the beds or seams of coal which occur at various levels and vary in thickness from one or two inches to several yards, and the beds of cannel and bands of ironstone and sandstone shale. The underclay on which the beds of coal rest makes good firebrick when free from carbonate of lime and other fusable material.

Summing the four together their economic products are coal, iron, lead, zinc, fireclay, and stone for building and decorating purposes.

No. 5 Subject.

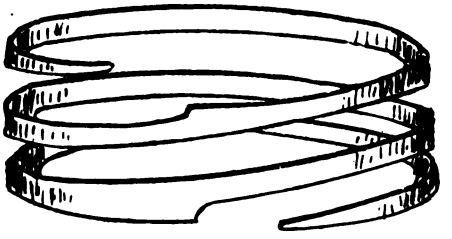
COLLIERY PLANT & MACHINERY.

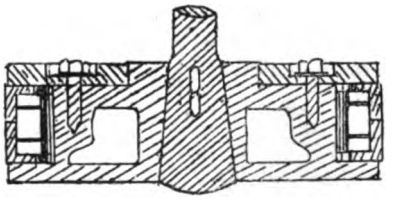
(60 marks to qualify.)

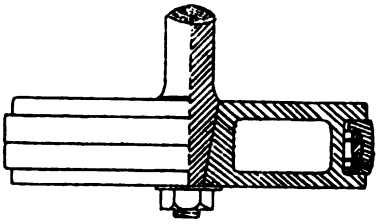
QUESTION 1.—The valve motion of non-reversing horizontal engine is found to be out of adjustment owing to the eccentric having become loose on the shaft and to the valve having shifted on the rod. Explain how you would proceed in order to fix the eccentric and valve in their proper positions. (20)

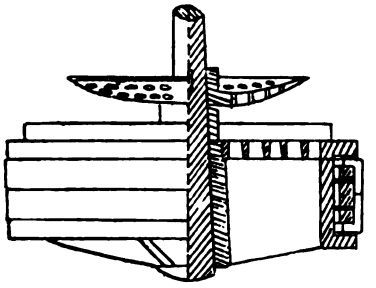
ANSWER.—I should take off the steam chest cover, and put the valve back in its proper position, which is done in the following manner:—Put the engine on dead centre and then fix the valve on the rod so as to almost close the steam port-holes, leaving a small opening as lead, to allow the steam port to be open before the piston has come to the end of its stroke. I should fix the engine on its other dead centre and examine the valve to see if it was right with each dead point of crank. The eccentric block is then fixed on according to this valve, taking care to give it such an angle of advance which would bring the valve to its mid-stroke when the crank is on the dead point. In this manner both the eccentric and valve can very soon be put in their proper positions again.

QUESTION 2.—Sketch the best form of metallic piston you are acquainted with, and describe it. (20)









ANSWER.—The above sketches represent a good form of piston and packing. The packing consists of an improved metallic elastic coil spring. The chief improvement in these

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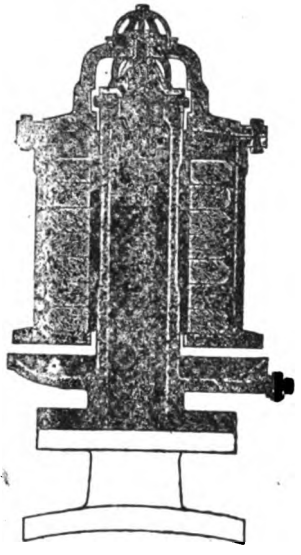
pistons is the substitution of steel coil springs cut from a solid steel hoop, instead of the cast-iron springs which were used previous to the introduction of this patent. They are cut from this solid steel hoop without any piecing or welding whatever, thereby avoiding all possibility of breaking from any defective welding or piecing—welding or piecing of any steel coil being unavoidable. They also retain their full elasticity both for horizontal and vertical tension.

The principle of these pistons, as will be seen from the illustrations, gives an equable and great elasticity, both for horizontal and vertical tension, with the least possible friction, and will yield to any reasonable irregularity of the cylinder. (A 30-inch dia. piston will expand one inch in diameter.) It moves with great ease and little friction, and still remains steam-tight in any part of the stroke. With the vertical it keeps all the parts firmly in their places, without rattle or noise. The last sketch shows the arrangement of a pump.

QUESTION 3.—Sketch a safety valve suitable for a steam boiler. (20)



ANSWER.—The valve as shown per sketch is a dead-weight safety valve. I have given this because when well constructed it has many advantages over the lever type, and is coming more in use. The great feature of the dead-weight safety valve is its great protection against overloading, as in the event of extra weights being applied it cannot fail to attract attention owing to the great amount of weight that would have to be put on to make a small difference in pressure.

QUESTION 4.—How would you guard against danger from sparks emitted from the brakes of underground hauling engines? (20)

ANSWER.—To guard against this danger I should have the engine-house built and rached with brick or stone, and carry the brickwork a short distance on each side of the engine-house. The foundation to be of bricks or masonry, with iron bed-plates for the engine to rest upon, and have no timber near the engine. In addition to this I should have no oily and dirty waste lying about the engine, but compel the engineman to keep the engine-house clean and free from all such refuse. The danger from sparking will then be very small.

QUESTION 5.—If the breaking strain of a wire rope is 22 tons, what would be its safe working load for winding out of a colliery shaft? (20)

ANSWER.—For vertical winding at a quick speed, the load, including weight of ropes between pulley and pit bottom when the cage is down, should be taken at $\frac{1}{10}$, or for moderate speed $\frac{1}{8}$. The safe working load would therefore be—

$$\frac{22}{10} = 2{\cdot}2 \text{ tons.}$$

QUESTION 6.—What are the provisions of the Coal Mines Regulation Act, of 1887, regarding the inspection of colliery machinery and appliances? (20)

ANSWER.—The provisions are to the effect that the external parts of the machinery and all other appliances shall be examined once in every 24 hours and a report made as to the condition in which they are found. See General Rule 5.

(To be continued.)

CORRECTION.

The following is a correction of an error which appeared in my answer to Question 8 in No. 5, Vol. IV., *Mining*:—

Question.—The water-gauge at the fan drift of a colliery stands at 2 inches when the quantity of air passing is found to be 150000 cubic feet per minute. What quantity would you expect to pass with the same expenditure of ventilating power if the water-gauge rose to 2·5 inches, owing to increased resistance in the airways?

Answer.—As the power expended remains the same it must come under the following rule;—

$$Q = \frac{\text{H. P.} \times 33000}{P}$$

Let Q. = Quantity. H. P. = Horse-power. P. = Pressure. W. G. = Water-gauge.

In the first place find H. P. exerted in passing 150000 cubic feet per minute, thus—

$$\text{H. P.} = \frac{150000 \times 2 \times 5{\cdot}2}{33000} = 47{\cdot}27 \text{ horse-power.}$$

$$\therefore Q. = \frac{47{\cdot}27 \times 33000}{2{\cdot}5 \times 5{\cdot}2} = 119993 \text{ cubic feet.}$$

The quantity expected to pass under the altered conditions.

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FATAL ACCIDENTS IN MINES, 1895.

THE annual return containing particulars and numbers of fatal accidents and deaths caused thereby, which occurred in mines and quarries during the year 1895 has now been issued. The total number of separate fatal accidents in mines classed under the C.M.R.A. (including those on private branch railways and in washing and coking coal) were 859, as compared with 813 accidents in 1894, and 809 in 1893. In 1895 the deaths caused by these accidents numbered 1,033, as compared with 1,127 deaths in 1894 and, 1,060 in 1893. The details of the accidents of the fatal accidents and deaths are shown in accompanying table.

During the year 1895 there were 45 separate fatal accidents, causing 53 deaths, in mines classed under the Metalliferous M.R.A., and 96 separate fatal accidents in quarries classed under the Quarries' Act, resulting in 96 deaths.

Summary of Separate Fatal Accidents and Deaths caused thereby in and about Mines classed under the C.M.R.A., 1895.

(Those on Private Branch Railways and Tramways and Washing and Coking Coal are included.)

Districts.	Explosions of Firedamp or Coaldust.	FALLS IN MINE.			IN SHAFTS.									MISCELLANEOUS UNDERGROUND.										ON SURFACE.					
		Falls of Sides.	Falls of Roof.	Total Falls.	Overwinding.	Ropes and Chains breaking.	Whilst ascending or descending by Machinery.	Falling into Shaft from Surface.	Things falling from Surface.	Falling from part way down.	Things falling from part way down.	Miscellaneous.	Total in Shafts.	By Explosives.	Suffocation by Natural Gases.	Irruptions of Water.	On Inclined and Engine Planes.	By Trams and Tubs.	By Machinery.	By underground frees.	Ropes and Chains breaking.	Sundries Underground.	Total, Miscellaneous Underground.	By Machinery.	Boilers Bursting.	Railways and Tramways.	Miscellaneous.	Total on Surface.	Gross Total.
SEPARATE FATAL ACCIDENTS—																													
Total in 1895	20	86	315	401	2	1	23	6	2	17	10	19	80	20	3	4	79	84	2	3	18	28	241	17	2	61	37	117	859
Total in 1894	22	109	525	434	1	2	9	3	4	22	2	26	69	12	4	...	57	59	9	...	5	30	176	14	...	67	31	112	813
DEATHS CAUSED BY THE ABOVE—																													
East Scotland	2	11	29	40	...	1	2	1	...	...	3	3	10	2	1	...	4	1	...	9	2	1	20	3	1	6	5	15	87
West Scotland	14	9	14	23	...	...	2	2	...	3	3	1	11	3	...	9	3	4	..	...	1	1	21	1	..	4	3	8	77
Do. (ironstone, &c.)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	..	...	...	...	1	...	.	...	...	...	1
Northumberland, Cumb., & N. Durham	1	1	25	26	...	..	1	...	...	3	...	...	4	7	...	...	6	19	...	...	.	2	34	2	..	4	2	8	73
S. Durham, Westmoreland, Yorks, N. Rdg	...	...	33	33	...	...	1	...	...	2	...	2	5	3	3	...	7	11	.	..	...	3	27	2	..	5	3	10	75
Yorkshire, Cleveland (ironstone)	...	1	5	6	...	...	..	...	...	...	...	...	...	...	...	..	1	1	...	...	..	...	2	...	...	...	1	1	9
Yorkshire	2	9	29	38	...	..	3	...	...	2	1	4	10	1	...	...	8	7	...	...	1	8	25	2	..	7	5	14	89
North and East Lancashire	5	7	23	30	1	...	..	...	...	1	1	1	4	1	...	8	7	3	1	..	1	3	24	...	...	3	3	6	69
West Lancashire and North Wales	1	9	36	45	...	...	...	2	1	1	2	...	6	...	..	..	5	7	...	1	1	1	15	1	...	7	4	12	79
Derby, Nottingham, Leicester, & Warwick	7	7	13	20	...	...	1	...	1	...	.	3	5	...	...	...	3	7	...	..	2	3	15	1	..	8	4	13	60
North Stafford., Cheshire, and Shropshire	...	5	11	16	...	...	...	...	...	...	...	3	3	1	1	77	3	6	...	2	1	2	93	...	2	1	...	3	115
South Staffordshire and Worcestershire	4	5	20	25	1	...	2	...	...	...	2	..	5	...	..	...	...	4	...	...	...	...	4	1	..	1	1	3	41
Devon, Dorset, Gloucester, Monmouth, Somerset & parts of Brecon & Glamorgan	9	5	29	34	...	...	8	...	...	1	...	1	10	2	..	.	5	2	..	...	1	1	11	2	...	3	2	7	71
South Wales	10	19	63	82	...	...	16	1	..	4	...	3	24	1	..	...	26	12	1	...	8	4	52	2	...	13	4	19	187
Total in 1895	55	88	330	418	2	1	36	6	2	17	12	21	97	21	5	94	79	84	2	12	18	29	344	17	3	62	37	119	1033
Total in 1894	317	109	335	444	1	2	13	3	4	22	2	30	77	12	4	...	58	59	9	...	5	30	177	14	...	67	31	112	1127

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MINING INSTITUTE OF SCOTLAND.

A MEETING of this institute was held in the Christian Institute, Glasgow, on Wednesday, Feb. 12th, Mr. G. A. MITCHELL (President) in the chair. After the admission of seven new members, the office-bearers for session 1896-97 were nominated as follows:—*President*: Geo. A. Mitchell. *Vice-Presidents*: James Hastie, Wallace Thorneycroft, James T. Forgie, Fred. J. Rowan. *Councillors*: Thomas Arnott, H. M. Caddell, Alex. Faulds, James Gilchrist, Alex. M. Grant, James Hamilton, James Hardie, Douglas Jackson, Robert Martin, John Menzies, Michael Ross, James Wyper.

Interesting discussions took place on Mr. H. M. Caddell's paper on "Gold Mining in the Hancaki District," and Mr. R. W. Dron's paper on "Southern Ayrshire Coalfield."

Mr. ROBERT MARTIN read a paper on

TREATMENT OF TIMBER FOR USE IN MINES.

He remarked at the outset that the treatment of pit-wood to render it durable and incombustible, though apparently a small matter, was of great importance for the safe working of mines. He referred to the frequency of underground fires in mines and fires on the surface, and described a method of treatment of timber known as the Henry Aitken method, which is in use at Niddrie Colliery. In this process the idea is to soak the timber in hot or boiling water containing a strong solution of common salt and chloride of magnesium. The timber treated, he continued, should be free of bark, well seasoned, and thoroughly dry. For this purpose it was kept under cover for a time. The props that had been found most suitable were those free of bark and natural sap. They were shipped from Sweden and several ports in Norway. The ordinary good class of battens and deals from Sweden can also be treated to great advantage. He went on to describe the plant at Niddrie Colliery, the cost of which he stated was about £50.

The paper was discussed at some length, and the discussion was eventually adjourned.

If matter for publication is sent in an envelope with the flap turned in (not sealed), book-post rate only will be charged.

Any information respecting Advertisements in this paper will be given on application to the "THE MANAGER," Advertisement Department, "Mining" Office, *Clarence Works*, Wigan.

SOUTH STAFFORDSHIRE & EAST WORCESTERSHIRE INSTITUTE OF MINING ENGINEERS.

A MEETING of this institute was held on Thursday, the 6th instant, at Mason College, Birmingham, under the presidency of Mr. R. WILLIAMSON.

In supplementing his paper on the

ELCTRICAL POWER PLANT AT HADEN HILL COLLIERY,

read at the last meeting, Mr. I. MEACHEM, jun., said that the installation had now been at work about six months, and it was possible to judge of its merits. The total cost of the installation was £2,289, while a steam plant would cost £1,089 less. On the other hand, however, they had the advantage of a light, and a saving of £73 per annum in candles, and a further saving of £30 per annum in the lights on the bank. Altogether there was a saving of £102 per annum. The result of the change, according to their sheets, showed a net reduction of cost equal to 3½d. per ton, or on the output £40 per week. They had, therefore, every reason to be satisfied with the result of the experiment.

Mr. HENRY LEA, who led the discussion, said that since the last meeting he had had an opportunity of visiting the Haden Hill Colliery, and of inspecting the surface electric plant and the hauling plant at the bottom. The working of the underground plant was, when he saw it, everything that could be desired. The simplicity of the arrangements and the ease of control were very striking, and there was, of course, an absence of the heat and leakage of steam and condensed water which would have been met with if there had been a steam engine down the pit doing the same work.

The CHAIRMAN admitted the value of electricity, but said he had yet to be convinced, though he had a plant of 60-horse power at work, that a steam engine fixed on the surface with ropes taken down the shaft could be beaten.

Replying to questions, Mr. MEACHEM said the cost of labour, including electrical engineer, attendant engineer, the stoker, and the attendant at the motor, was 19s. 7d. a day, which worked out at 0·47 of a penny per ton.

Mr. BROWN (Walsall) said there was no doubt electricity would not compete with rope haulage at short distances. In long distances, however, electrical haulage was a considerable advantage, and it was now

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possible to make the motor quite safe, even though the machine should be sparking in the midst of explosive gases. The motors were now being made so that work could be done with them wherever it could be done with a safety lamp.

After further discussion, a vote of thanks was accorded Mr. Meachem for the paper, and Mr. Lea for his contribution on the subject.

THE LAW RELATING TO

MINES, MINERALS, & QUARRIES.

By T. F. UTTLEY, F.I.I., Manchester,
Author of "Factory and Workshop Inspection," Editor of "Labour Contracts," 4th Edition, &c., &c.

(Specially written for this Journal.)

INUNDATIONS AND FLOODS.

WHEN water accumulates in one mine it follows that there are often inundations in an adjoining one. Every mine owner has the right to deal with the water in his mine whether open or concealed, for each owner is entitled to obtain the greatest advantage he can from the property, but in doing so he must not do any damage to his neighbour, except in so far as such acts are consistent with the mine owner's own rights, as a neighbouring mine owner is expected to protect his own interests. The custom in the district is usually consonant with this rule. A reasonable use of underground water for mining is always allowable.

A liability attaches to land which lies on a lower level in its relation to that which is higher to receive any water which comes or is let down upon it, provided the water flows in a natural course.

Where the occupier of the higher ground artificially alters the course of the current he sends down, the occupier of the lower land is not bound to receive the diverted flow, though if the flow from the higher to the lower be natural, the lower occupier may take means to guard himself against such invasion of water and stop the flow of the water on himself, for if such water came upon him and he had adopted no means of prevention there would be no ground for action or injunction.

In the case of a person collecting and keeping on his land water, where it would not naturally come, he is entirely responsible for this himself and for damage which may result from the escape of the water. This is illustrated by the case of Rylands *v.* Fletcher, where the defendant had in connection with his mill made a reservoir on a plot of land adjacent to that where the plaintiffs worked their mines. The plaintiffs in their workings reached the passages of some disused mines, which passages were connected with shafts leading to the land above. Soon, however, after the water was introduced into the reservoir it burst through the old shafts and flooded the plaintiffs' mines, and the defendant was held liable for that damage.

A local authority making sewers under the Public Health Act, 1875, would not be responsible for the sewage flowing into the adjoining mine inasmuch as such sewers ought to be supported by the mines, and any discharge from the sewers must consequently result from the carelessness of the mine owners. By the Water Clauses Act, 1847, however, it is provided that where waterworks are constructed under statutory authority, and this Act applies, nothing is to prevent the undertakers from being liable to any action or other legal proceedings to which they would have been liable for any damage or injury done or occasioned to any mines by means or in consequence of the waterworks in case the same had not been constructed or maintained as provided by this Act or any special Act.

If mines become flooded through water flowing along a railway cutting and penetrating through the course of the railway into the mines below the railway company will be liable for the flooding, and any damage so caused will not be the subject of compensation under the Railway and Lands Clauses Acts, 1845. It may be taken, therefore, that when the rights and obligations of a railway or other corporation are governed by an Act of Parliament, the company or corporation will be liable if the works they have authority to execute are not maintained or constructed according to their statutory provisions. Of course there will be no liability where the escape of water is through the Act of God or of a third party.

A right for one mine owner to discharge his water upon the land of his neighbour may be acquired by grant or prescription.

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In the case of a landowner whose mines are compulsorily purchased by a railway company and he has mines under the railway and adjoining mines lying on both sides of the railway, he can, under the Railway Clauses Consolidation Act, 1845, make water communications between the mines for drainage purposes. Mining easements in respect of water may arise in respect of land containing mines which is under the Land Tax Redemption Act of George III; also under the Inclosure Act, 1859, and by the Crown, as regards the foreshore or the adjacent lands under the Crown Lands Act, 1865.

With regard to the drowning of coal pits and mines a statute of the time of 13 George II. provided that treble damages might be sued for and recovered against any person who unlawfully, wilfully, and maliciously diverted water from any river, brook, watercourse, channel, or land flood, or conveyed water into any coal-work mine, pit, or delph of coal, or any subterraneous cavities or passages with intent to damage such property. A similar right of action is given against any person who destroys or obstructs any sough or sewer (which has been a sough or sewer in common for fifty years) made for draining any coal work, mine, pit, or delph of coal.

As to the remedies against a man who discharges water from his mine upon the property of his neighbour, or drains his mine through the property of his neighbour, and has no right to do so, the injured party can claim damages, or can obtain compensation by way of water-leave rent upon the minerals taken out of the offending mine and drained through the injured party's. An injunction may also be sometimes obtained by the injured party. If the invasion of the water is considered a nuisance an order may be made for its abatement. In endeavouring to obtain a legal remedy the injured party may obtain an order for inspection of the offending party's property.

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NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

A GENERAL MEETING of the members of this institute was held in the Wood Memorial Hall, Newcastle-on-Tyne, on Saturday, Feb. 15th, Mr. THOMAS DOUGLAS (President) in the chair, when Part II. and III. of the

REPORT OF THE PROCEEDINGS OF THE FLAMELESS EXPLOSIVES COMMITTEE,

was submitted by Mr. A. C. Kayll, engineer to the committee.

The previous report of the committee dealt with experiments on explosives in mixtures of air and combustible gases, and those now under review were conducted under the same conditions but with mixtures of coaldust. In preliminary experiments with blasting powder quantities of dust, varying from ½lb. to 16lbs., were used and in almost every instance the dust was ignited by the powder shot, the smaller quantity being as readily ignited as the larger. A series of experiments was then conducted with the several explosives, when stemmed and unstemmed, fired into the tube containing a quantity of dust partly in suspension at the time of firing the shot, and another series was made in which explosives under the same conditions were fired into the tube containing a quantity of dust in a state of rest. The conditions of these experiments and the results obtained in each case are detailed in the extensive tables which are embodied in the report. The following are the conclusions deduced from these experiments with coaldust:—(1) The high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit) are less liable than blasting powder to ignite mixtures of air and coaldust, with or without the presence of firedamp. The explosives cannot be relied upon as ensuring absolute safety. (2) The experiments have shown that ignitions of mixtures of air and coaldust with or without the presence of firedamp can be obtained when there is present a much smaller quantity of coaldust than has been previously supposed to be necessary.

In summing up the experiments the committee state that some very interesting results have been obtained during the course of the enquiry. Firstly, the sensitiveness to ignition of coal-gas as compared with pit-gas has been clearly demonstrated. Secondly, the presence of flames in an explosive gaseous mixture has been proved (the flames some-

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times being first observed at points several feet remote from the cannon) without ignition of the gaseous mixture ensuing. The retarded ignitions of the explosive mixtures of coal-gas and the point of first ignition of gas mixtures occurring many feet distant from the cannon are interesting features in the enquiry. All the safety explosives ignited mixtures of coal-gas; none ignited mixtures of coaldust *in situ*; and there were only two instances throughout the whole series of experiments (exclusive of those with coal-gas) where a mixture was ignited by stemmed shots.

The conclusions arrived at by the committee from the whole of the experiments are as follows:—(1) The high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit) on detonation produce evident flame. (2) The high explosives are liable to ignite either inflammable mixtures of air and firedamp—or air and coaldust—or air, firedamp, and coaldust, and therefore cannot be relied upon as ensuring absolute safety when used in places where such mixtures are present. (3) The high explosives are less liable than blasting-powder to ignite inflammable mixtures of air and firedamp—air and coaldust—and air, firedamp, and coaldust. (4) The experiments have shown that ignitions of mixtures of air and coaldust, with or without the presence of firedamp, can be obtained when there is present a much smaller quantity of coaldust than has been previously supposed to be necesssry. (5) It is essential that similar examinations of the working-places and precautions which are in force in mines where blasting-powder is used, should be rigidly observed where a high explosive is employed. (6) In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened and not abolished by its use. (7) In view of the changes from time to time made in the proportions and constituents of high explosives, it is desirable that the name of the explosive should be printed on the wrapper of each cartridge, and that the date of manufacture and the proportion of the ingredients used in the manufacture of the explosive should be printed on the case of each packet of cartridges. (8) As these explosives alter in character if improperly kept, it is necessary that every care should be taken in the storage to ensure their being maintained in good condition.

Mr. KAYLL, in concluding the report, said it had unfortunately been the lot of the committee to prove a negative—that these explosives were not flameless, and not absolutely safe; but he ventured to say, in proving that, they had done no mean service in view of the confidence which was placed in these explosives at the time the committee were appointed. Such explosives constituted valuable and important inventions, and it was only necessary to compare them with common powder or nitro-glycerine to realise that they led them a step forward in the matter of blasting in coal mines.

In reply to the President, Mr. Kayll said there was no distinctive significance to be attached to the terms *ignition*, *inflammation*, and *explosion* used in the report. Where it was stated that the cannon recoiled after firing, this was not due to the shot itself but to the pressure of the tube caused by the ignition of the dust.

Mr. A. L. STEAVENSON referred to the clause in the Coal Mines Regulation Act, 1887, which enacted that in a gaseous or dusty mine, an explosive which cannot ignite gas or coaldust may only be employed. It was clear from the report that no such explosive was to be had, and the wording of this clause required amendment. In view of further probable legislation it was desirable that attention should be drawn to the difficulties which the workmen themselves placed in the way of the introduction of high explosives.

The PRESIDENT asked if any comparison could be instituted between the results obtained by the committee and those obtained by the various commissions on explosives.

Mr. KAYLL said the explosives themselves had been altered so much that those experimented on by the earlier commissions could scarcely be considered the same, and practically the only experiments conducted on the same lines as their own were those of Mr. Winkhaus, who had been endeavouring to demonstrate that certain explosives were only dangerous when used in given quantities. Mr. Winkhaus was, however, very much astonished to see for himself flames produced at Hebburn from explosives which he contended could not ignite gas or dust.

Mr. JOHN GERRARD endorsed the committee's conclusion No. 5, it was very desirable that high explosives should be used with the same precaution as gunpowder.

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Mr. HENRY HALL considered it important to notice that the experiments of the committee showed that comparatively small quantities of coaldust would, under certain conditions, produce an explosive atmosphere, and they pointed out that this was contrary to the view generally held by mining engineers. Those who carefully studied this final report of the committee could not fail to be convinced that in dry coaldust they had to reckon with an agent capable of even more disastrous effects than firedamp itself. The report afforded a decisive confirmation of what was known as the "coaldust theory."

Mr. J. G. WEEKS referred to the fact that the dust used in the experiments was taken from the deeper, dry and dusty mines in Durham, and it was open to doubt whether dust from the shallower mines of Northumland would have given quite the same result. If restrictions were to be imposed by Government as to the use of explosives there should be some classification of mines; at his own collieries for instance some 1,500 shots a day had been fired for the last 40 or 50 years without an explosion, and that with ordinary powder.

Mr. M. W. PARRINGTON said several serious explosions had been attributed to shots fired in airways where volumes of air had been passing. It was a question yet to be decided whether this was not the most dangerous part to fire a shot when coaldust was present, and he thought this pointed to the great desirability of experiments to test coaldust under different conditions of atmospheric pressure and volumes of air.

A cordial vote of thanks to the committee for their labours, and especially to Inspector Hedley and Mr. A. C. Kayll, having been adopted, the discussion was adjourned and the meeting terminated.

ANSWERS TO COMPETITION QUESTIONS

GIVEN IN No. 4, VOL. IV.

MECHANICS.

(1) What is the largest diameter of drum which can be used to raise a load of 6 tons with a pair of engines 24 inches diameter, 4 feet stroke? Take effective working of engine as two-thirds.

Answer.—A cylinder 24 inches diameter = $24^2 \times .7854 = 452.4$ sq. in. area.

I would have the drum of such diameter that one engine would be able to raise the load. Assuming we have steam at 60 lbs. pressure, then

Total Pres. $= 60 \times 452.4 = 27144$ lbs.

Taking the effective pressure at $\frac{2}{3}$, then

Power $= \frac{2}{3} \times 27144 = 18096$

Motion of P $= 2 \times$ stroke.

Motion of W = cir. of drum in ft.

Then Power × Motion of P = W × Motion of W.

i.e., $18096 \times 2 \times 4 = 6 \times 2240 \times$ Motion of W.

$$\therefore \text{Cir.} = \frac{18096 \times 8}{6 \times 2240} = \frac{754}{70} = 10.77 \text{ ft. cir.}$$

$$\therefore \text{Diam. of Drum} = \frac{10.77}{3.1416} = 3.42 \text{ ANS.}$$

JOSEPH MARR.

This question appears to have given considerable trouble, and it will be as well to call attention to a few points which are worthy of notice. As one crank may be on dead centre when the load has to be started, only one cylinder must be taken into account in the calculations. Working the question out on the principle of the lever, the moment acting at one end of the lever is the effective steam pressure in lbs. × area of cylinder in square inches × twice the piston stroke; and the moment acting at the other end is the load in lbs. × *circumference* of drum in feet. These moments should be exactly equal to each other. As the effective working of the engine in the above question is taken at the same proportion (two-thirds), as was adopted in deducing our abbreviated formulae the answer may be found by the following formulae:—

$$d^3 = \frac{D \times L \times 18}{P} \quad \therefore D = \frac{P \times d^3}{L \times 18}$$

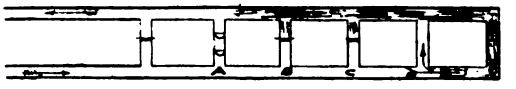
6 tons = 13440 lbs.

$$\therefore D = \frac{60 \times 24 \times 24 \times 24}{13440 \times 18} = \frac{24}{7} = 3\tfrac{3}{7}$$

Diameter of drum = $3\frac{3}{7}$ feet. ED.

REMOVING ACCUMULATIONS OF GAS.

(2) State briefly how you would remove an accumulation of gas, and what men and materials you would require? Give sketch if necessary.



Answer.—I would not remove an accumulation of gas until all the men, except those rendering assistance, were out of the mine, and would not allow man or light, on any account, on the return side of the gas. Then I would sweep out the gas before me, little by little, by cautiously forcing the air-current upon it, beginning at the intake side and gradually carrying the fresh air forward. To obtain a good strong air-current it might be necessary to shut off some of the other splits and thus increase the w.g. produced by a given power, in consequence of reducing the

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total quantity. In reference to the sketch the shaded portion of the road shows where the gas has accumulated. I would station a man at A to regulate the air; to dilute the gas, B and C stoppings have been opened and rebuilt as the gas has been removed. At D the brattice is shown by the firm lines. I should require at least four men, one at the separation doors, one for rebuilding the stoppings, and two for the bratticing. The material required would be brattice, nails, hammer, and perhaps a few lengths of pipes. If there are any cavities in the roof the pipes would be useful to clear away the gas, which could be done by placing one end of the pipe in the cavity and carrying the other end through a stopping into the return. By having experienced and careful workmen an accumulation of gas can be successfully and safely removed by the above method.

JAMES LAVERICK.

METHOD OF WORKING A MINE SUBJECT TO SPONTANEOUS COMBUSTION.

(3) What method of working (longwall or pillar and stall) do you deem preferable for a mine subject to spontaneous combustion? Other circumstances not to be taken into consideration.

Answer.—In a mine subject to spontaneous combustion, and where the conditions adopting the method of working are not to be taken into consideration, I would prefer to work such a mine on the longwall method for the following reasons, viz.:—(1) The coal can be better removed, and the space where the coal is taken out can be built solid with stone taken from the roof or floor. (2) The working can be better restricted into districts, having the working as compact as possible, so that the coal can be removed by a quickly moving face. (3) The ventilating currents can be better applied and thus keep the coal surface as cool as possible.

Whereas in working the mine pillar and stall, pillars of coal are left in, and when the weight of the strata above is very great and the coal is a little soft, the coal would be crushed and broken about the pillars, which would have a tendency of being in favour of spontaneous combustion, because where the coal is crushed and broken and left open to the action of the atmosphere a very slow rate of combustion goes on, that is, if the atmosphere is not sufficient to keep the coal surface cool. But still in these cracks the small coal being in a finely divided state developes heat and smoulders until it sometimes breaks out into a flame. Then again, where the pillars of coal are being removed, sometimes large falls from the roof take place and prevent all the coal from being taken out. Timber is also left behind in the gob, and this is in favour of spontaneous combustion, because the air playing through the gob would have a tendency of getting heated and would act on the surface of the coal; this heat would escape too slowly to prevent ignition of the coal from taking place. So we see from the above reasons longwall is the best method of working the coal.

The chief points to prevent spontaneous combustion are, to have a sufficient quantity of cool air passing throughout the mine so as to keep the coal surface as cool as possible, and to keep all slack or small coal and timber out of the gob, and these can be better served by working the mine on the longwall method.

WILLIAM MITCHELL.

AWARDS

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Jos. Marr, 95, Oakenshaw, nr. Willington, County Durham.

Commended.—J. Lund, 14, Radcliffe St., Woodhouse Lane, Wigan.

Question 2.—James Laverick, Butterknowle, R.S.O., County Durham.

Commended.—Sam. Davies, Barrow Farm, Worsbro., near Barnsley; H. Hall, 15, Yardley Terrace, Ryhill, nr. Wakefield; T. Webster, Birchley Rd., Billinge, nr. Wigan; Jas. Laverick, Butterknowle, R.S.O., Co. Durham; Jos. Marr, 95, Oakenshaw, near Willington, Co. Durham; T. E. Aitchison, Green Hill, Dunaskin, Ayrshire; J. Gilmour, 7, Craig Place, Billshill, Lanarkshire, N.B.

Question 3.—William Mitchell, Dalharco, Patna, Ayrshire, N.B.

Commended.—H. Hall, 15, Yardley Terrace, Ryhill, near Wakefield; T. Bent. Railway Street, Tow Law, County Durham; W. E. F. Leadbetter, 82, Front Row, New Bolsover, near Chesterfield; J. E. Keefe, Amble, Northumberland.

CHANGE OF ADDRESS. The Tredegar Iron and Coal Company, Ltd., proprietors and shippers of the Tredegar "Smokeless" Welsh Steam Coal, have removed their London offices from 28, Queen Street, Cheapside, to 7, *Fenchurch Avenue, E.C.*

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COMPETITION QUESTIONS.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before March 6th, 1896.

We invite readers to forward questions for this competition.

(1) Describe with suitable sketch how you would work an outcrop seam of coal 4 feet thick, dipping 1 in 4.

(2) Two pits are 80 feet apart, the deeper shaft being 300 yards, seam of coal 5 feet thick, gradient 1 in 6, dip coal to be hauled by engines into the bottom and not interfere with rise haulage, stoop and room working—show doors, stoppings and air-crossings, and position of engines, and four or five stoops to dip and rise and bottom pillars, coal to be raised from both shafts. Give sizes of all pillars. (Award doubled for this question.).

ANSWERS TO CORRESPONDENTS.

W. T. T.—Questions sent in for the Competition are given when suitable, no matter whether the sender requires an answer for his own private use or not.

J. S.—Much obliged for your suggestion, but the correct meaning of a definite gradient was given a short time ago. However, here it is again. Inclination 1 in 4 means 1 rise to 4 horizontal, and not 1 rise to 4 measured on the slope.

INTENDED CANDIDATE.—Five years served with a mining engineer is we think accepted by the Manchester and the Wigan Examination Boards as sufficient qualification; providing the candidate has in the discharge of his duties to go down the mine regularly. The secretary for both boards is Mr. T. H. Ellis, Wigan.

J. W. MCKEAN.—Thanks for your congratulatory letter. Have forwarded the specimens you suggest.

J. FOX.—Very glad to learn that you have got a Second-class certificate, and that you attribute your success to reading our paper. Stamps to hand.

J. W. WOODBRIDGE.—Thanks for correction. It is impossible to prevent mistakes; but it is always our desire to rectify them.

A meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers was held on the 6th inst., and a meeting of the North of England Institute of Mining and Mechanical Engineers on the 15th inst. Particulars of these are given in the present issue.

At a meeting of the Manchester Geological Society held on the 11th inst., an important paper by Messrs. J. Barnes and W. F. Holyrod, was read on "The Rocks and Fossils of the Yoredale Series of the Marsden and Saddleworth Valleys."

CORRESPONDENCE.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

AIR-CROSSINGS.

Sir,—I submit the following in answer to "Tyro," hoping they will be of some use to him:—

An air-crossing to resist the force of an explosion should in itself have a roof and floor formed in the solid strata, *i.e.*, the floor of the air-crossing should be a few yards above the roof of the intake. This is done by starting at two given points in the return, on each side of the intake, and piercing into the strata (roof) at such an inclination that they will meet directly over the intake and have a few yards of solid strata between the floor of the air-crossing and the roof of the intake. Such an air-crossing as the above is well illustrated in *Mining*, No. 13, Vol. III, page 154, by Mr. J. Carter; also how to build strong masonry stoppings to be able to resist the lateral pressure produced by an explosion.

VENTILATING A SINKING PIT.

I would ventilate the sinking pit by placing a small exhaust fan on the surface, 2 or 3 feet in diam., and connect tubes to the inlets of the fan. By carrying these tubes down the side of the shaft to a few yards above the sinkers they will prevent them from being troubled with the gases given off by the strata and those produced by blasting, viz., CH_4 and CO, respectively. The shaft would serve as the downcast and the tubes the upcast. Therefore, it will be seen that the sinkers would always be working in pure air. Most certainly there will be an engine on the surface to raise the debris, etc., out of the sinking shaft, then the power required to drive the fan may be transmitted from this engine to the fan by belt or rope gearing.

GEORGE DAYKIN (Bishop Auckland).

LITERARY REVIEW.

MINING PLANS & DIAGRAMS FOR MINING STUDENTS. By G. L. Kerr, M.E. Price 2s. 6d.

A very excellent collection of mining plans and sketches, and as explanatory as is possible without a text. Considering the labour entailed in such a work the book is very cheap. The subjects illustrated are Surface Arrangements, Boring and Sinking, Pumping, Ventilating Appliances, Safety Lamps, Haulage Arrangements, and Modes of Working. It contains in all, at a rough calculation, some 200 graphic and well got up illustrations. With a view to making this collection more valuable we suggest that a small reference book, giving a brief description of each sketch, should be published in conjunction with it. This need not increase the price very materially.

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Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 8 Vol. IV. Mar. 7th, 1896.

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Editorial Notes.

The inquest in connection with the Tylorstown colliery explosion was concluded on the 25th ult., when the following verdict was returned:—"We are of opinion that the cause of the explosion was the firing of a shot in gas in Daniel Williams' road in No. 8 Pit, and that the air passing through the faces was charged with gas and probably came in contact with the film of gas in Daniel Williams' road, and the explosion was also accelerated by coal dust. We also are of opinion that no one living is responsible for the explosion." The following riders were added:—"We recommend that a competent man be appointed to fire all shots, one in each shift. We are of opinion that a personal and competent under-manager should be appointed to have sole charge of the night shift in each pit. We were surprised to understand by the evidence given that Her Majesty's Inspectors have not made a thorough and systematic inspection of the No. 8 pit during the past 15 months, and we also recommend that practical workingmen be appointed as assistant inspectors of mines." Mr. Abel Thomas, Q.C., M.P., who appeared for the company, pointed out that it would be a breach of the Act to appoint two managers, and the jury substituted the word "overman" for "under-manager" in their rider.

* * *

A serious overwinding accident resulting in the death of eight lives, occurred on the 20th ult., at the Westleigh Collieries, near Wigan. So far as we can gather from the coroner's inquiry the safety hook with which the rope was provided was of a kind that detaches the rope, but does not hold the cage in suspension. As a complement to the hook, safety catches were employed, which had they worked properly would have held the cage after the rope had been detached. There was nothing wrong with the detaching hook, it acted properly, but the safety catches failed in their part of the work, and the cage with its occupants fell to the bottom of the shaft. The safety catches were of the lever description which rise out of the way of the cage in its ascent, but fall back again by reason of their own weight after the cage has passed. It appears probable that the catches would have acted properly had they been given sufficient time, but the cage did not rise high enough to clear the catches and allow them to fall back before the rope was detached. At the inquest the jury returned a verdict of accidental death. The accident has received a considerable amount of notice, correspondence and otherwise, in the local papers, and as is usual in such cases, many of the writers know very little of what they speak. The unitiated judge from these writers that there is a want of some safety appliance to prevent these accidents, and that those employed in the mining industry are deficient in inventive faculties. Anyone who has the slightest knowledge of mining appliances will not be mislead however. The appliances already in use for the prevention of accidents from overwinding are such that if proper precautions are used there is not one chance in a thousand of a serious accident occurring. Needless to say safety appliances—no matter how effective—are useless if not kept in order, and placed in such a position that they will do their work. Some time ago we advocated the general adoption of safety catches, but only to act as a supplement to a detaching hook of the class that support the cage after detachment, and not to be the only safeguard against the cage falling down the shaft. Adopt the detaching and suspension hook, have the safety catches of proper strength, keep them in good order, and place them in a suitable position for their work, and there need be no fear of an accident from overwinding.

* * *

At a meeting of the Western Pennsylvania Central Mining Institute, Mr. Bernard Callaghan, Connellsville, Pa., read an interesting paper on "Stoppings." He said the general interpretation of the law with regard to stoppings is practised by building brick or stone stoppings, with the joints made close with mortar, so that they are strong enough to resist all normal pressures and tight enough to prevent leakage. He however pointed out that in the event of an explosion these solid stoppings would be all broached and destroyed, but being so strong the force of the blast would extend to the shaft and do incalculable mischief; and that when these brick stoppings are destroyed current ventilation is impossible, and consequently the rescue of those living in the mine is prevented by the afterdamp. He proposes the general use of hanging-door stoppings to act as relief valves, and therefore they will open by the pressure generated by the explosion, and so relieve the compression by diffusion, that comparatively little damage will be done, and the ventilation will be at once restored and the afterdamp carried off with the normal return current. Mr. Callaghan introduces to notice the door stoppings put in use by Mr. James Jackson, in the Valley Mine, the construction of which is as follows:—The door is hung like the end of a gate of a mine car (*i.e.*, from the top) and leans against a frame securely fixed, and the door is made airtight at the closure with canvas sheeting, so that these stoppings are practically as good in preventing leakage as the stone or brick ones.

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The Eastern Limits of the Midland Coalfield.*

By Pro. Edward Hull, LL.D., F.R.S., F.G.S.

AT first sight, when looked at by the aid of a geological map of England, the Leicestershire and Warwickshire coalfields might be supposed to extend indefinitely under the triassic and more recent secondary strata which form the surface of East Anglia and the intervening district; and this notwithstanding the ominous uprise of very old pre-carboniferous rocks, in the centre of Leicestershire, including Charnwood Forest. At one time these ancient rocks, concerning whose geological age there is still much uncertainty, were regarded as having formed an island round which the coal measures were deposited on all sides; in which case the coal strata might be expected to occur to the east and north of the island, as well as to the west and south of it; extending, it might be, indefinitely eastwards under the tract of the Wash and its borders into East Anglia. But the author regrets that recent investigations, supported by the information gained in boring operations under the district referred to, do not tend to confirm this view.

Leicestershire.

It had always been hoped—the writer might say expected—that a considerable reserve of coal would be found under the triassic strata lying to the south aud west of the Leicestershire coalfields. Collieries have been opened to work the main seam under the new red sandstone at Overseal and Netherseal in this direction. But the condition of this important seam, interrupted and much spoiled as it is by bands of sandstone, appears to indicate an approach to the original margin of the carboniferous basin. The proximity of this marginal land, formed of much older rocks, has, the writer regrets to say, been recently determined by direct borings undertaken by the Netherseal Colliery Company at a distance of about one mile south of the existing colliery, and gave the following generalised results:—

		Feet.
1	New red sandstone, with pebbles of quartz.	262
2	Coal measures above the main seam.....	514
3	Older palæozoic rocks	19
	Total	795

The older palæozoic rocks (No. 3) consist of reddish, purple, and grey grit, sandstone, and micaceous quartzite, destitute of fossils, and thus contrast with the coal measures above (No. 2), which are full of plant remains. A second boring put down about one mile further to the south-east, gave similar results, when reddish vitreous quartzite, slightly micaceous, was penetrated at a depth of 760 feet. This rock bore a strong resemblance to the Hartshill stone of Warwickshire. On examining these cores the writer came to the conclusion that they belong to the cambrian system—a conclusion in which Pro. Lapworth concurs. It is clear, therefore, that a ridge of these very old rocks here replaces the middle and lower coal measures, together with all the lower carboniferous strata, and causes the productive coal measures of the Leicestershire coalfield to terminate towards the south-west, just as the old rocks of Charnwood Forest form their limit in the opposite direction. Between this concealed ridge and the visible Charnwood Forest rocks there lies a deep bay of coal measures concealed by triassic strata, in which the Ibstock and Bagworth collieries are located, and the boring through the red marl near Desford, about six miles west of Leicester, which is said to have reached coal measures, shows that this bay stretches far towards the south. Further east, however, the bosses of syenite of Mount Sorrel, Barrow Hill, Stony Stanton, and Sapcote, rising above the plain of the new red marl, appear to be clear indications that the centre and east of Leicestershire are underlain by rocks much older than the carboniferous.

Warwickshire.

The eastern margin of the Warwickshire coalfield is clearly indicated by the lower silurian (or upper cambrian) beds, consisting of the Hartshill quartzite and Stockingford shales, which rise from below the coal measures, from Atherstone on the north to the neighbourhood of Bedworth on the south, where the coal measures pass below the new red marl. Coal is now worked below this formation as far as Wyken, and may extend some distance yet further south. Some years ago the writer was under the impression that coal measures might set in to the east of the ridge of Hartshill, but further consideration, fortified by further researches, now leads him to abandon this view, and to consider it as improbable that coal will be found under the tract around Hinckley under the triassic strata. Further borings are desirable in order to determine this point with certainty.

* Abstract of a Paper read before the Federated Institution of Mining Engineers.

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NORTHAMPTONSHIRE.

The borings which have been put down in this county have been undertaken chiefly in search of water. But in at least two cases the palæozoic rocks have been proved beneath those of mesozoic age, and therefore throw light on the structure of the county at considerable depths. These the writer will further describe:—(1.) At Orton, a village about 10 miles north of Northampton, a boring has been put down commencing in the lias, and after passing through the new red marl entered rocks consisting of hard grits and slates. On examining specimens sent to the writer at the time (1881), he came to the conclusion that they were of lower silurian or cambrian age. (2.) Near the town of Northampton there have been several borings in which the rocks reached are, according to Mr. Whitaker, older than the carboniferous, and the trias (red marl) is thin, and in one place absent. In one of the borings, however, carboniferous limestone with characteristic fossils, determined by Mr. Etheridge, was passed through at a depth of 800 feet. Mr. Etheridge suggests that here is an indication that in the tract between Northampton and the exposed coalfield of Warwickshire there may be "an extended coalfield." This the writer much doubts, for although the presence of carboniferous limestone at Northampton presupposes the former existence of coal measures, he fears that, owing to an extended period of denudation previous to triassic times, the upper carboniferous beds have been swept away in the tract referred to. This, however, is a point that can only be absolutely settled by direct boring experiments, which are much to be desired.

BUCKINGHAMSHIRE, &c.

Somewhat further south, at Bletchley, a boring was made a few years since in search of water by the London and North-Western Railway Company, and a rock was reached beneath the lias, a specimen of which the writer had an opportunity of examining. It proved to be a felsite, and seems to indicate the presence of old rocks invaded by trap. Other borings at Ware, Cheshunt, and Culford have proved that upper silurian beds lie beneath the mesozoic strata. These localities are, however, too far removed from the district of the Midland coalfields to be further noticed here. They are rather connected with the structure of the region of the London basin, and are only interesting to us as confirming the absence of coal under this part of England.

SUFFOLK.

A most important boring has recently been carried out under the east of England by the Eastern Counties' Coal-boring Association. To the subscribers to this association it must needs be disappointing; but it is of great interest to geologists as going very far towards settling the question regarding the presence or absence of coal under East Anglia. The position of the experiment is the valley below Crepping Hall, near Stutton, close to the borders of Norfolk and Suffolk, and the following is a generalised section of the boring:—

	BORING AT STUTTON, SUFFOLK.	Feet.
1	Gravel, &c.	16
2	Tertiary strata	54
3	Upper, middle, and lower chalk	874
4	Gault clay	50
5	Palæozoic grits and slates	534
	Total	1528

The palæozoic rock (No. 5), which has a high dip southwards, consists of grey slates, resting on purple and dark-grey grits and slates, much crushed and fissured and destitute of fossils; the specimens when tested did not effervesce with acid, showing that calcareous rocks were absent. The absence of fossils is much to be regretted; but to the writer the rock appears undoubtedly to be pre-carboniferous and, in fact, to belong to that group of rocks of indeterminate age which might be referred either to the lower silurian or cambrian, of which we have examples at Orton and elsewhere. The evidence which we obtain from this boring tends to confirm the view of the absence of coal measures under East Anglia, certainly for a considerable area around Stutton; and if further borings are undertaken by the company they ought to be placed a considerable distance either to the north or south of the county boundary between Norfolk and Suffolk. It ought to be mentioned, however, that carboniferous slate with *Posidonia* was reached some years ago below the chalk at Harwich. Further boring experiments in well-selected spots are certainly desirable, and may result in agreeable surprises; but as regards this point the writer does not profess to be sanguine.

SOUTH STAFFORDSHIRE & WORCESTERSHIRE.

It now only remains to deal with the question of the limits of the South Staffordshire coalfield towards the east and south. As Professor Jukes has shown, a silurian land surface, formed of strata slightly rising towards the east, occupied originally what is now the southern portion of this area. The uprise of the silurian quartzite of the Lickey

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Hills through the permian beds proclaims the limit of the carboniferous strata in a southerly direction. But, considerably to the north of this, the southern limits of the productive coal measures have been proved by the shafts which, some years since, were put down by Messrs. Dawes at Wassel Grove and Manor Farm, about two miles south of Halesowen. Here the Thick coal seam was only represented by "fragments of carbonised plants mixed with sandstone and fragments of silurian rock; while, a little lower, the shales of the upper silurian formation with *Pterygotus* were passed through for some considerable depth." This experiment, so costly and disappointing to the enterprising owners of the shafts, settles the question of southern limit of the Thick coal, and proves that it does not extend much (if at all) beyond the margin of the permian beds, where they sweep from west to east across the coal measures a little north of the Clent Hills. On the other hand, the successful experiment to prove the Thick coal seam at Sandwell Park, near Birmingham, under the permian beds may be regarded as a set-off to the failure at Wassel Grove, and shows that the silurian ridge keeps well to the east of this spot. In fact, it seems probable that the limit of the productive coal measures with the Thick coal seam passes in a north and south direction under the new red sandstone of Birmingham. This ridge curving round from east and north probably divides to some extent the productive coal measures of Warwickshire from those of South Staffordshire, and ranges northwards in the direction of Barr Beacon; but new experiments, by boring or otherwise, are much to be desired, in order to define more accurately the extent of this concealed barrier of silurian rocks.

In conclusion, it will be inferred from the evidence before us that the old cambro-silurian rocks formed a ridge trending from Salop and Worcestershire eastwards into the eastern parts of the counties of Warwick and Leicester, which was very irregular in its outline, and sent out ridges in a northerly direction separated by intervening bays. Against the shelving sides of these ridges the coal measures were deposited, filling up the bays as the region gradually subsided under the carboniferous waters, and in consequence the upper coal measures cover a more extended area than the productive middle beds, and these than the lower carboniferous, which are altogether absent in South Staffordshire and Warwickshire.

EXAMINATION QUESTIONS,

WITH ANSWERS BY

J. CARTER, First-Class Certificated Manager.

Questions given in the South-Western District, Sept., 1894, for Under-Managers' Certificates of Competency.

(The figures in parenthesis show the number of marks obtainable.)

No. 1 Subject—ARITHMETIC.

(60 marks to qualify.)

Q. 1.—A pillar of coal weighs 7 tons 16 cwt. 17 lbs., what is its weight in lbs.? (10)

ANS.—$7 \times 20 + 16 = 156$ cwt. $\times$ $112 + 17$ $= 17489$ lbs.

Q. 2.—If an adit or heading rises 16 feet in a total length of 768 yards, what is the rise per yard? (10)

ANS. $\dfrac{768}{16 \times 12} = 4$ inches to the yd.

NOTE.—768 yards is taken as the horizontal measurement.

Q. 3.—One cwt. of steel hammers cost £1 7s. 4d., and they weigh 7 lbs. each, what is the cost of each hammer? (10)

ANS. 1 cwt. = 112 lbs.

$$\text{No. of hammers} = \frac{112}{7} = 16$$

$$\therefore \text{Cost of each hammer} = \frac{27/4}{16} = 1/8\tfrac{1}{2}.$$

Q. 4.—How many revolutions per minute must be made by a drum of 4 feet diameter to give a speed of 6 miles an hour to the rope? (30)

ANS.—Cir. of drum $= (4 \times 3{\cdot}1416) =$ 12·5664 feet.

One mile $= (1760 \times 3) = 5280$ feet.

$$\therefore \text{Revs. per min.} = \frac{5280 \times 6}{12{\cdot}5664 \times 60} = 42{\cdot}016$$

Q. 5.—Three men (A, B, C) worked at the same rate of wages, and earned a total sum of £3 17s. 7d. A worked $3\frac{1}{2}$ days, B worked $4\frac{1}{2}$ days, C worked 6 days. How much money did each man earn? (20)

ANS.—The total number of days worked by A, B, and C $= (3\frac{1}{2} + 4\frac{1}{2} + 6) = 14$.

The average wage per day for each man

$$= \frac{77/7}{14} = 5/6\tfrac{1}{2} \text{ per day.}$$

A's money $= 66{\cdot}5\text{d.} \times 3{\cdot}5 = \dfrac{232{\cdot}75}{12} = 19{\cdot}3958\text{s.}$

B's money $= 66{\cdot}5\text{d.} \times 4{\cdot}5 = \dfrac{299{\cdot}25}{12} = 24{\cdot}9375\text{s.}$

C's money $= 66{\cdot}5\text{d.} \times 6 = \dfrac{399}{12} = 33{\cdot}25$ s.

77·5833s. = £3 17s. 7d. 77·5833s.

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Q. 6.—If you pay a 1d. per inch thick per yard forward for ripping top 6 feet wide, how much per cu. ft. does the ripping cost? (20)

ANS.—

Cost per yd. @ 1d. per in. for 1ft. thick = 1s.

No. of cu. feet in a yard = $1 \times 6 \times 3 = 18$ cu. ft.

$\therefore$ Cost per cu. foot = $\frac{12}{18}$ = ·66d. = or $\frac{2}{3}$d. per cu. ft.

Q. 7.—A stall turns out 30 tons per week, and deadwork is as follows:—3 sets of timber @ 1s. 6d. cach; 2 cogs @ 11d. each; 3 yds. cutting bottom, @ 9d. per yd.; and 4 trams of rubbish, @ 2½d. per tram. How much does the deadwork cost per ton of coal? (20)

		s.	d.
3 sets of timber	@ 1/6 =	4	6
2 cogs	@ 11d. =	1	10
3 yds. cutting bottom	@ 9d. =	2	3
4 trams of rubbish ...	@ 2½d. =	0	10
Total cost of deadwork	=	9	5

Cost per ton, deadwork = $\frac{9/5 \times 12}{30}$ = 3·766d.

No. 2 Subject—VENTILATION.

(60 marks to qualify.)

Q. 1.—What quantity of air passes per minute through an airway 6 feet high and 8 feet wide, when the velocity or speed of the air-current is 6½ feet per second? (20)

ANS.—Area of airway = $(6 \times 8) = 48$ sq. ft.

Vel. per min. = $(6{\cdot}5 \times 60) = 390$ ft. per min.

$\therefore$ Q. of air per min. = $48 \times 390 = 18720$ c. ft.

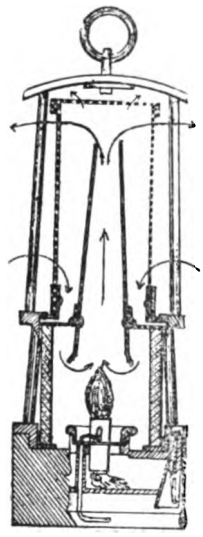
Q. 2.—Describe the barometer and explain its use. (20)

ANS.—The barometer in its simplest form consists of a bent glass tube partly filled with mercury. The tube is from 35 to 36 inches long and ¾ inch diameter of bore, and is closed at one end. The object of the barometer is to denote the pressure of the atmosphere: at the ordinary pressure, the mercury stands in the tube at a height of about 30 inches, but a decrease in pressure sometimes causes it to fall as low as about 28 inches, while an increase may cause it to rise to 31 inches. Attached to the barometer is a scale by means of which the height of the mercury in the tube may be read.

The barometer is of great use to mining operations, because it shows the various changes of atmospheric pressure which at times are considerable. Danger is to be apprehended in fiery mines, when a sudden depression of atmospheric pressure occurs, because the result of this is, that the gases pent up in the old workings and goaves of a mine are freely liberated. Gas being much more sensitive than mercury, we find oftentimes, records of gas having been found in roadways and places previously clear, even before any noticeable change in the barometer takes place. This teaches us that too much trust must not be placed in the barometrical readings, but points out most clearly that we must always be on the alert for changes in the atomspheric pressure.

Q. 3.—Describe a good safety lamp for the use of colliers in fiery mines. (20)

ANS.—I consider the Meuseler to be a good form of safety lamp for colliers' use in fiery mines. This lamp is somewhat similar



in principle to the Clanny, but considerably improved and modified (see sketch). The flame of this lamp is surrounded by a thick glass on the top of which is a cylindrical gauze, and inside this gauze is a conical metal chimney. The chimney is held in position by a wire gauze diaphragm, and extends downwards below the gauze inside the glass cylinder. Its object is to carry the fresh air direct to the light and keep the glass cool. The air which feeds the lamp passes through the gauze diaphragm (which supports the metal chimney) and down the outside of the conical chimney to the light, so that the products of combustion pass up the chimney and out of the lamp by the apertures in the top. This lamp goes out in the presence of firedamp, because the flame becomes too large to allow the small chimney to carry off the products of combustion, hence the light becomes extinguished. A disadvantage of this lamp is that it goes out when placed slightly out of vertical position, but the advantages gained in its use overcome this objection:—It gives a good light, and withstands a good current—when bonnetted 40 feet per second, not bonnetted 12 feet per second.

(To be continued.)

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The Arniston Collieries, Midlothian.*

By J. M. Thomson, B.Sc.

DESCRIPTION.—The Arniston Collieries are situated about ten miles south-east from Edinburgh, in the Carboniferous Limestone Series, and at an altitude of about 450 feet above the level of the sea, on the North British Railway. The minerals are principally on the estates of Arniston and Kirkhill, owned by Mr. Dundas, of Arniston, and the remainder is on the estates of Carrington and Harvieston, leased from the Earl of Rosebery and Mr. J. Y. Trotter-Cranston, of Dewar and Harvieston, the whole consisting of about 3,000 acres. The pits, however, are all sunk on the Arniston estate. To the south-east it rises towards the old Roman Camp, again dipping away in the opposite direction, forming an anticline. To the north-west it continues dipping for a considerable distance, flattens out, and no doubt will again rise in the same direction, and form a syncline. Three faults run through the field nearly parallel with the line of dip—(see fig. 1)—the one to the south throwing up the limestone which is burned to a considerable extent on the same estate. Coal is raised from two pits—the Gore Pit, which is sunk to the Kailblades, 228 yards deep, and the Emily Pit, 312 yards deep, sunk to the Parrot Seam. Both these pits are downcasts. The people employed in connection with the colliery number about 800, and the quantity of coal raised is about 800 tons per day.

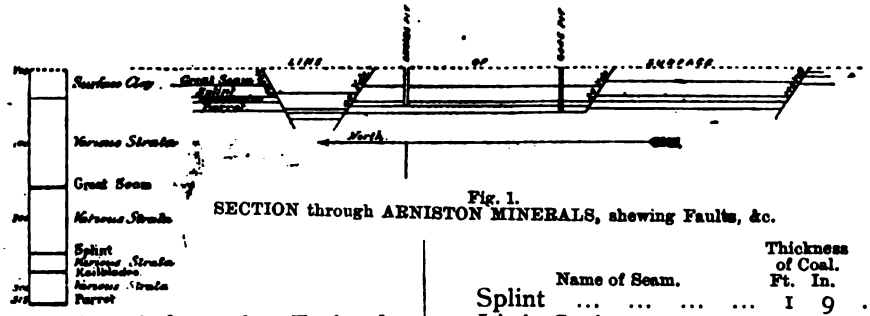
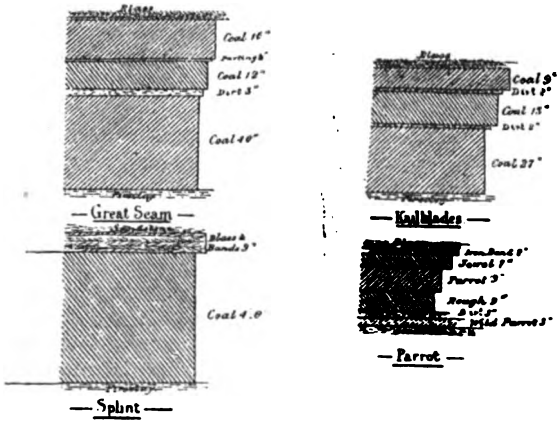


Fig. 1.
SECTION through ARNISTON MINERALS, shewing Faults, &c.

The following are sections of the coal seams taken in the Emily Shaft, their depth and thickness :—

Name of Seam.	Thickness of Coal. Ft.	In.	Depth from Surface. Yds.	Ft.
Splint	1	9	... 72	3
Little Coal	1	9	... 118	2
Soft Coal	2	3	... 122	0
Siller Willie	3	0	... 140	2
Great Seam	6	3	... 160	3
Diamond Coal	2	2	... 164	1
Coal	2	6	... 172	0
Coal	2	5	... 182	3
Coronation Coal	3	6	... 194	1
Wee Coal	1	7	... 198	0
Coal with Parting... ...	2	11	... 206	0
Coal	2	3	... 214	2
Little Coal	1	6	... 226	1
Coal	1	9	... 232	2
Splint Coal	4	0	... 244	0
Scleaty Coal	3	0	... 260	3
	Ft.	In.		
Kailblades 4	2			
Fireclay 2	0			
Little Splint 2	3			
	8	5	... 286	0
Parrot Seam :				
Jewel Coal ...0	9			
Parrot Coal ...0	9			
Rough Coal ...0	11			
	2	5	... 312	0



Sections of Seams.—Fig. 2.

There are four of these seams worked by the Company, viz.:—The Great Seam, a steam coal of excellent quality; The Splint Seam, a rich household coal; The Kailblades, another steam coal used extensively by the millowners in the Esk Valley, and for locomotive purposes; The Parrot Seam, a first-

* Extract from Journal of the British Society of Mining Students'

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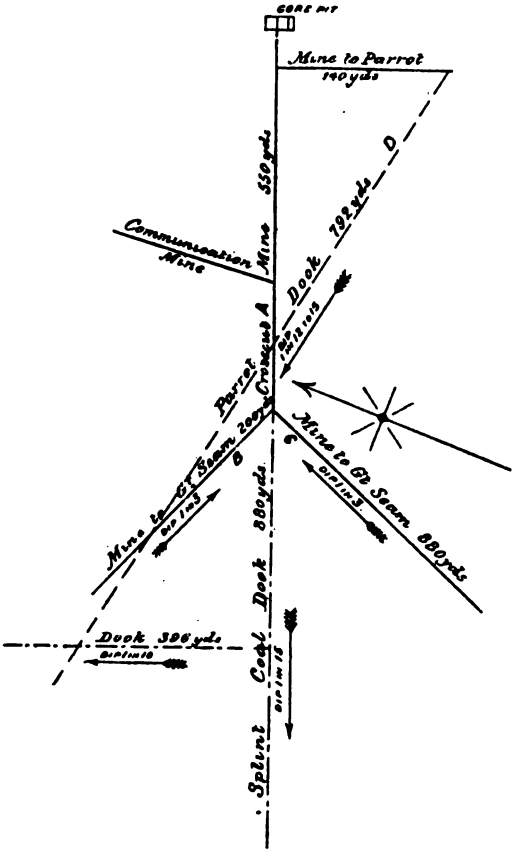
class and well-known gas coal. See fig. 2. The upper portion of the Parrot Seam is termed the Jewel Coal, and varies from 7 to 12 inches in thickness. This part of the Parrot Seam is in great demand, and commands a very high price in the market as a household coal.

Shafts.—These seams are worked from two shafts, the Gore and Emily. The Gore pit is 228 yards in depth, and is 14 feet by 10 feet in section. The Emily Pit is 312 yards in depth, and is 9 feet by 14 feet in section. Both being situated conveniently to the North British Railway, no difficulty is experienced in surface haulage. This is accomplished by three locomotives built by Manning, Wardle & Co., of Leeds, each having 12 inch cylinders with 21 inch stroke, each being a duplicate of the other.

Winding and Hauling Engines.—The working engines for the Gore Pit are coupled, with 26 inch cylinders and 5 feet stroke. The drum is conical, 13 feet tapering to 11 feet. Four hutches are drawn at a time with a single-decked double cage, and the total weight of coal and hutches averages nearly three tons. The size of the winding rope is 1¼ inch Plough steel. The other plant at this pit consists of one pair of coupled engines, 16 inch cylinders and 3 feet 6 inch stroke, which are used for drawing from a dook 1,200 yards in length; one single-acting engine, 12 inch diameter, with 2 feet 6 inch stroke, used for endless rope haulage; and another small engine, 12 inch cylinder and 2 feet 6 inch stroke, working a dynamo for electric lighting, and transmitting power to a motor working an underground pump. The screening arrangements are of the old type, and are arranged to separate the coal into the different sizes required.

The engines used for winding at the Emily Pit are horizontal coupled 22 inch cylinders and 4 feet 6 inch stroke, drum 10 feet diameter. Two hutches are drawn at one time with a single-decked double cage. Three slides are used in the shaft, two on one side of the cage near the ends, and one in the centre on the other side. The winding rope is 1 inch diameter, Plough steel. The other engines are two pairs of horizontal coupled, each having 21 inch cylinders and 4 feet 6 inch stroke; these are used for dook haulage; almost the whole of the output is drawn from the dip. No. 1 engine, working the 800 yards dook, has an 11 feet drum, and is geared 1 to 2. No 2 engine working the 600 yards dook, has an 18 feet drum, geared 1 to 2½. The steam pressure is 45lbs. The ropes for each are ¾ inch Plough steel, led down the shaft in 4 inch square rhones. The screening arrangements are the same as at the Gore Pit.

Boilers.—At the Gore Pit there are three Lancashire boilers, 30 feet by 7 feet, 45 lbs. pressure. Engine Pit: two Lancashire boilers of the same dimensions. Emily Pit: there are six boilers, Lancashire type, 30 feet by 7 feet, 45 lbs. pressure, covered with composition and 4½ inch brickwork. These boilers supply steam to brickmaking machines and other engines in connection with the brickworks.



Plan of Main Haulage Roads.—Fig. 3.

Haulage and Systems.—On the road A (fig. 3) endless rope haulage is adopted. The rope is placed into hooks, or jiggers as they are termed, on the end of the hutch. The hutches are placed on the ropes at intervals of about 20 yards apart. B and C are self-acting inclines. In the dook, main

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rope haulage is adopted. This being the flattest portion of the field, little difficulty is met with in the conveying of the coal from the working face to the main siding, as owing to the flatness of the strata, the miners can get the hutch taken direct to their working places.

Emily Pit.—As before mentioned, nearly the whole output is got from the dooks, the gradients of which are from 1 in 1½ to 1 in 3. No. 1 Dook is at present 800 yards in length, and is to be extended: this dook is brick-arched throughout its entire length. No. 2 Dook is 600 yards in length, slightly flatter, owing to its direction not being at the same angle as No. 1 Dook, this direction of driving being rendered necessary to facilitate the working of the various seams lying at the extreme north-west corner of the field. On the main levels, which are driven off from the side of the dook, haulage is done by horses.

(To be continued.)

(The continuation includes Pumping, Ventilation, Systems of Working, &c.)

Competition.

In lieu of the ordinary Competition Questions this issue we will give a PRIZE of HALF-A-GUINEA for the best

DESCRIPTION OF A COLLIERY.

We refer competitors to the description of a colliery which appears this issue and to that of Newbattle colliery, which appeared a short time ago, as a guide to work from.

To be sent in not later than March 20th, 1896.

A general meeting of the Federated Institution of Mining Engineers was opened at Sheffield, on Wednesday, the 19th ult., under the presidency of Mr. G. A. Mitchell. The following papers were considered: "The Eastern Limits of the Midland Coalfield," by Prof. Edward Hull, F.R.S.; "Electric Welding," by Mr. T. Scott Anderson; "The Vibromotor as applied to the Screening of Small Coal," by Mr. Emerson Bainbridge, M.P.; "The Matabele Goldfields," by Mr. F. G. Shaw; "Photography in the Technology of Explosives," by Mr. Alfred Siersch; "Lead and Lap of Winding and other Engines," by Mr. Hargrave Walters; "The Coal-Washing Plant at the Wirral Colliery, Neston, Cheshire," by Mr. James Platt. In the afternoon and during the following day several collieries and works were visited. Extracts from some of the above papers will be found in our current number.

The Vibromotor.*

By Mr. Emerson Bainbridge, M.P.

THE rapid vibrating movement of the mechanical shaking or revolving screens will be especially familiar to all who have noticed the strains which its reciprocating action often exerts upon the screening plant structure. The revolving screen is somewhat rough in its treatment of coal, and it is not to be recommended for tender kinds. The type of small coal screen which is the subject of this paper is named by the inventor "the vibromotor." It is claimed that an almost perfect sub-division of the different sizes of coal and similar materials can be obtained. The screen is of the usual design. The novelty consists in an ingenious application of driving gear, which automatically balances the moving weight when the screen is in motion. A circular movement is imparted which resembles the hand riddle. The principle is not new, as screens of this type have been in use for some time, but the absence of all balancing when at work rendered them almost as objectionable as the jigging screen. In the vibromotor the machine consists of a frame containing a perforated plate or wove mesh, which is suspended by four hangers which are free to move in any direction. To the end of this screen or to any convenient point is attached a vertical pedestal bearing carrying a spindle, on which is fixed a lever and weight. This spindle (with lever and weight) is made to revolve by means of a flexible driving-rod, which is also free to swing in any direction, the spindle being driven by means of a half-crossed belt or rope passing round a horizontal pulley, and as the weighted lever (which is purposely made out of balance) revolves, no vibration is concentrated on any fixed point or abutment, the whole of the work done being imparted to the screen itself. The hangers and the flexible driving-rod being at liberty to swing in any direction are, therefore, incapable of transmitting any motion to the framework or adjoining building—that is to say, the only opposing weight to the gyrating weight or vibromotor being the screen (which is not fixed in any way, but free to swing), a reciprocating action is set up between the two—the two weights assuming their centre of gravity. The action of the vibromotor is very gentle, and it may be run at much higher speeds than has hitherto been practicable.

* Abstract from a paper read before the Federated Institution of Mining Engineers.

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Coal-Washing Plant at the Wirral Colliery, Neston, Cheshire.*

By Mr. JAMES PLATT.

AT Wirral colliery the management decided to erect an Elliott coal-washing plant, which, on account of its efficiency, simplicity, and small cost, was most suitable for their wants. The Plant erected at Wirral colliery is capable of dealing with 100 tons of coal per day of ten hours. One washer only is fixed, but there is space for another washer, the other adjuncts, including elevators, shafting, conveyor, and power being sufficient, with slight additions, for two washers. The coal consists of all that will pass through a screen with 1 inch and 1¼ inch parallel bars; the dust, peas, beans, and nuts all being mixed together. A vibromotor screen is provided, so that a separation can be made when desired, and the fine coal or nuts only washed; or, if another washer be erected, each kind can be washed separately, one in each trough.

The Elliott washer is designed on the principle of the trough washer, with the difference that it is automatic and adjustable. It consists of a steel trough, 60 feet long, 1½ feet wide at the bottom, and 2½ feet wide at the top, the sides opening from the bottom. This trough is fixed at an inclination of 1 in 12; and scrapers (taking the place of the fixed stops or dams used in the trough washer) are attached at intervals of 6 feet to an endless chain, passing round sprocket wheels fixed at each end of the trough, and caused to move slowly along the bottom of the trough from the lower to the higher end, and against the stream of water; the returning part of the chain and scrapers is supported above the trough on suitable rollers and brackets.

Water is supplied by a centrifugal pump (3 feet in diameter), which gives an ample supply through a valve for regulating the quantity of water supplied to the trough; and an overflow pipe allows any surplus water to run back to the pump. The water is admitted at the upper end of the trough and runs over the scrapers down the trough to the lower end. The scrapers are 4 inches deep and fit the trough accurately at the sides and bottom. A screen of fine mesh is provided at the lower end of the trough to receive and separate the water from the coal.

* Abstract of a paper read before the Federated Institution of Mining Engineers.

The coal is conveyed by a horizontal conveyor from the screen and delivered into an elevator, and is then screened by a vibromotor screen when required. An iron hopper is provided to receive the coal from the elevator or vibromotor screen when in use. The hopper is situated above the centre of the washer trough, and delivers the coal by means of an automatic feed into the trough, midway between its ends, *i.e.* 30 feet from either end.

The operation of separation by washing is performed on the same principle as that of all other coal-washers, viz., the difference of the specific gravities of the coal and the dirt. The dirt, being the heavier, sinks to the bottom of the trough, and is caught by the scrapers, which convey it slowly to the upper end of the trough, and thence deliver it into a small tram or coal waggon for removal. The coal being the lightest, sinks more slowly, and is carried away by the water to the lower end of the trough, and thence delivered on to the gauze screen, which extracts the water from the coal and delivers it into the boot of an elevator, which raises it into a storage box. The storage box is provided with a hoppered bottom and a sliding door to facilitate the loading of the waggons, which run on rails under the storage box.

The coal is admitted into the trough by means of an automatic feed. The quantity of water is regulated by means of a valve. By these combined means of regulation a wide range of conditions can be complied with. The water which is drained from the coal by means of the moving gauze screen returns to the pump, which elevates it to the washer, and it is used over and over again. A small supply of fresh water is needed to make good the waste which escapes with the coal and dirt. The quantity of water circulated is about 150 gallons per minute, and the centrifugal pump is large enough for this purpose. The whole of the plant is of an extremely simple construction, and the only parts likely to require repairs for a considerable time are the pump and gauze screen, although if properly attended they cannot give much trouble. The washer was guaranteed to wash 10 tons an hour, but it has been found capable of washing 11 tons an hour. The amount of ash contained in the slack before washing was 25 per cent., and, after washing, analysis showed 4·2 per cent. of ash in the coal, of which 1·20 per cent. is free dirt and 3 per cent. is natural residue. The dirt appears to be perfectly free from coal.

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Answers to Competition Questions

GIVEN IN No. 5, VOL. IV.

MECHANICS.

(1) A vertical column of cast-iron water pipes is 300 feet long; the upper portion for 200 feet is of 12 inches diameter, and the lower portion of 100 feet is of 10 inches diameter. Required the weight of pipes and water, and the pressure of the water per square inch on the bottom.

(Only answer and method of ascertaining same required.)

Answer.—In calculating the weight of pipes for the depth of 300 feet we must aim at what thickness the pipes are to be, which is found by the following rule:—

$$\frac{R \times P}{1120} = \text{Thickness in inches.}$$

R = Radius of pipe in inches.
P = Pres. per sq. in. due to head of water.
1120 = lbs. half-a-ton, as factor of safety.

We must also allow for the flanges of the pipes, which are generally in 9-feet lengths. A general rule when finding weight of pipes is to add 1 foot extra to each pipe for the flanges.

Thickness of 12-inch diameter pipe for 200 feet =

$$\frac{6 \times 200 \times \cdot 434}{1120} = \cdot 465 \text{ inches.}$$

Thickness of 10-inch diameter pipe will be calculated for the total depth, viz., 300 feet.

$$\therefore \quad \frac{5 \times 300 \times \cdot 434}{1120} = \cdot 584 \text{ inches.}$$

$$\therefore \quad D^2 - d^2 = w$$

Therefore—

D = Outside diameter of pipe in inches.
d = Inside diameter of pipe in inches.
w = Weight per lineal foot of cast-iron in lbs., and the constant equals 2·45.

Now, taking the pipes in 9-feet lengths, in 200 feet we have—

$$\frac{200}{9} = 22 \cdot 2 \text{ pipes}$$

or say, practically, 22 feet to be allowed for flanges. Therefore to calculate the weight of the 12-inch diameter pipe—

$D^2 - d^2 = 12 \cdot 930^2 - 12^2 = 167 \cdot 1849 - 144 =$

$23 \cdot 1849 \times 2 \cdot 45 \times 222$ ft. = 12610·26 lbs.,

or 5 tons 1·26 cwt.

To calculate for 10-inch diameter pipe—

$$\frac{100}{9} = 11 \text{ feet, say for flanges.}$$

$D^2 - d^2 = 11 \cdot 168^2 - 10^2 = 124 \cdot 72 - 100 = 24 \cdot 72$

$\therefore \quad 24 \cdot 72 \times 2 \cdot 45 \times (100 + 11) = 6722 \cdot 6$ lbs.,

or a little over 3 tons.

$$\therefore \quad \frac{12610 \cdot 26 + 6722 \cdot 6}{2240} = 8 \cdot 63 \text{ tons}$$

total weight of pipes.

The quantity of water in the pipes may be found thus:—A cylinder, 1 inch diameter 1 foot long, contains ·034 of a gallon, therefore for the 12-inch diameter pipes, 200 feet long = $12^2 \times 200 \times \cdot 034 = 979 \cdot 20$ gallons.

For the 10-inch diameter pipes, $10^2 \times 100$ feet × ·034 = 340 gallons contained in the 10-inch diameter pipes for a depth of 100 feet.

Total quantity of water = 979·20 + 340 = 1319·20 gallons.

Now there are 10 lbs. contained in a gallon of water— $\therefore \quad 1319 \cdot 20 \times 10 = 13192$ lbs.,

$$\text{or} \quad \frac{13192}{2240} = 5 \cdot 889 \text{ tons}$$

total weight of water in whole length of pipes.

The pressure per square inch on the bottom equals total head of water × ·434. This ·434 is equal to the lbs. pressure per square inch for 1 foot in depth.

$\therefore \quad 300 \times \cdot 434 = 130 \cdot 2$ lbs. pressure per sq. inch on the bottom.

The total pressure on the base would be equal to the area of the 10-inch pipe multiplied by the pressure per square inch.

WM. MYCOCK.

MODE OF WORKING TWO SEAMS OF COAL.

(2) How would you work two seams of coal dipping 1 in 3 of the following section:—

Hard Shale.....	Roof
Coal	3 feet
Light Warrant	3 to 10 feet
Coal	3 feet
Strong Warrant.....	Floor

Give suitable sketches to illustrate the answer.

Ans.—Perhaps the best, safest, and most economical mode of working the seams would be as follows:—(1) To drive three parallel levels direct to the boundary, and cross-levels right and left, driven out of the main levels every 120 yards, as per sketch. (2) The under

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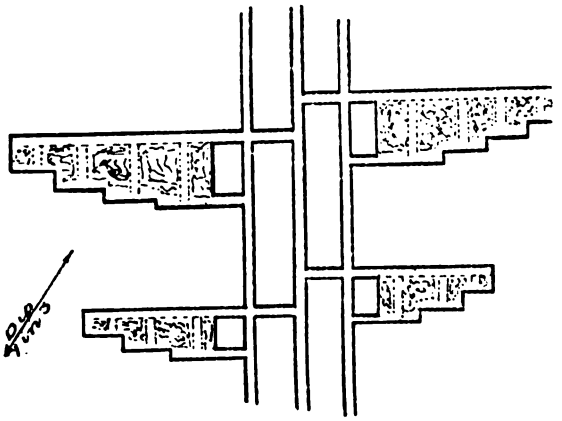
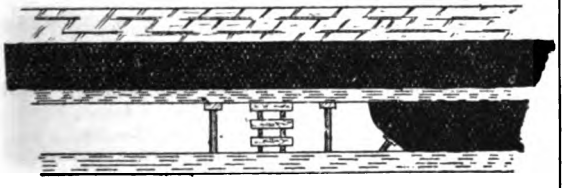


coal seam worked from 4 to 6 yards in advance of the top seam to the rise, while the middle warrant (debris or dirt) is supported by chocks and timber at the most suitable distance apart, the gate-roads being supported by packs 10 feet wide, the back gob left open. (3) The chocks and timber taken out so as to allow the middle warrant to fall, then the top seam worked out within about 3 or 4 feet to the advancing face of the lower seam, or within one line of props and chocks to the under seam coal face. The row of chocks under the warrant will prevent it breaking down on to the coal face, and also answers as a platform for the workmen to work the top seam with more safety, and facilitates the inspection of the roof along the line of face and gob of the (hard shale roof) above.



(4) The seam should be worked on the step longwall principle, the gates 22 yards apart, going in the direction of half-end and bord, with the object of cutting across the angle of slips or jacks in the cover of the seam. (5) The coal must be jigged down the gates to the branch levels so as to be drawn out in loads to the main level, then to the pit bottom. (6) By driving to the boundary less timber will be required, and less of it lost. There will be less risk to life and limb, and more coal got out, and in a better state for the market. The sketches will make it more clear to the mining student how best to work such seams. SAMUEL DAVIES.

TUNNELLING.

(3) In driving a pair of levels you meet an up-throw of 50 yards. What size of tunnels would you drive, and at what gradient? What distance apart would you cut openings through, and what would be the length of the tunnel?

Answer.—The size and gradient of tunnels I would drive would solely depend upon the extent of the royalty beyond the fault and the system of haulage I intended to adopt.

If there was a large area of coal to be worked beyond the fault I would make the fore-drift a good size in order to be able to deal with a large output, say 12 feet wide and 7 feet high. The back-drift only being intended for travelling and ventilation, I would make it, say 9 feet by 7 feet, which would be of sufficient size to pass, at a reasonable velocity, from 16,000 to 20,000 cubic feet per minute, this quantity being sufficient for a good sized district.

The gradient of the tunnels could only be decided upon by considering the system of haulage in vogue. But in these days of endless rope haulage I would probably prefer to put on a *self-acting* endless rope and make the gradient 1 in 4, or 9 inches to the yard.

The length of the tunnels therefore would be—

$$\sqrt[2]{(50\times 4)^2+50^2} = \sqrt[2]{200^2+50^2}$$
$$= \sqrt[2]{65000} = 255 \text{ yds. practically.}$$

The distance apart of the cut-throughs would be decided upon after commencing the drift. As long as I was able to keep the drifts well ventilated I would not think of making a cut-through, because this is all dead work, but when the air in the face of the tunnel was insufficient to dilute and carry off the noxious gases generated by blasting, etc., then there must be a connection made between the tunnels, which would probably be about every 50 yards. To ventilate the tunnels between cut-throughs I would use sheet-iron tubes of about 18 inches diameter, making the tubes the return.

JAMES SKIPSEY.

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Correspondence.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.
Envelopes to be marked "Correspondence."
Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.
Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

MECHANICS.

Sir,—I would be much obliged for an answer to the following:—Mr. W. Tate states in his mining arithmetic, "To find the dimensions of winding engines when H.P. is given, multiply the H.P. by 126050 and divide by the number of revolutions multiplied by the pressure of steam and by the number of cylinders, and extract the cube root, gives diameter of cylinder." Would any reader kindly let me know how the constant 126050 is arrived at. An early answer will oblige.

TYRO.

VENTILATION.

Sir,—If, with the fan running at 60 revolutions and a W.G. of 2·7 inches, the doors leading into the fan drift on the surface were opened, what effect wonld it have on the speed of the fan and on the W.G.? Please give reasons for your answer. A. NORTH.

PUMPING.

Sir,—I would be much obliged for an answer to the following:—Required the best and most economical pumping plant capable of delivering a maximum quantity of 120,000 gallons of water through a height of 300 yds. in one hour. The above is for a permanent pumping station, and initial outlay need not be considered. E. H.

[We will give the ordinary award of 2/6 for the best answer to the above question.—ED.]

Answers to Correspondents.

W. S. (Hindley).—We did not consider your essay sufficiently interesting to publish.

Box E. 20.—Have written you as requested. We wish you the success you deserve. Write us again.

N. B. Y.—As stated in our answer to J.S. we cannot refer back, and if you are not commended in the Competition you may be assured, as a general rule, that your answer is a poor one. Your name may, however, have been inadvertently missed out in the case you mention. Literary communications should be addressed to the Editor of "Mining," Clarence Works, Wigan.

J. S.—We do not remember your solution to the geometrical question and it is now too late to refer to it. If correspondents send their letters accompanying the Answers to Competition Questions they cannot expect to receive attention in the proper time. It is distinctly stated that correspondence should be sent independent of any other matter. We know, however, that the awards for the answers to the questions to which you refer were given for the best.

DON.—When inclination is stated in terms of the perpendicular and horizontal it may be changed to degrees by the following *approximate* rule:—Divide the horizontal measurement per unit of the perpendicular into 57 and the result will be the inclination in degrees. Thus, 1 in 4 gives 4 horizontal per unit of perpendicular, and 57 ÷ 4 = 14·25 degrees. The correct inclination for 14 degrees is 1 in 4·01, so that it will be seen that the above rule is fairly correct.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—William Mycock, New Silksworth, *via* Sunderland, County Durham.
Commended.—Thos. Lawrenson, 269, New Boston, Haydock, Lancs.; A. W. Button, Park Terrace, Willington, Durham; J. H. Berry, 36, Chatsworth Street, Walkden, near Bolton; J. W. Tate, Windy Arbour, Talke, nr. Stoke-on-Trent, Staffordshire; A. H. Meakin, Mansfield Road, Eastwood, Notts; J. Laverick, Butterknowle, R.S.O., Co. Durham; J. Hardman, 59, Barnsley Road, Wath-on-Dearn, near Rotherham; J. E. Keefe, Amble, Northumberland; A. Ratcliffe, 61, Catlow Hall Street, Oswaldtwistle; G. W. Hedley, Medomsly Edge, Medomsly, R.S.O., Durham; T. Hill, Crosby Villa, by Maryport, Cumberland; James Skipsey (no address sent in).

Question 2.—Samuel Davies, Barrow Farm, Worsbro., near Barnsley.
Commended.—T. E. Aitchison, Greenhill, Dunaskin, Ayrshire; H. Hall, 15, Yardley Terrace, Ryhill, nr. Wakefield; A. Clayton, Seaton, Workington, Cumberland; W. Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.; T. Jones, Manor Road, Abersychn, Mon.

Question 3.—James Skipsey (no address sent in).
Commended.—Thomas Fisher, 59, Barnsley Road, Wath-on-Dearn, near Rotherham; James Davies, Clynderwen House, Neath Road, Maesteg; Thos. Hill, Crosby Villa, by Maryport, Cumberland; W. Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.; J. E. Keefe, Amble, Northumberland.

[In answers to Question No. 3, in finding the length of tunnel required, a great number of competitors made an error as to the method of finding what I may here term the hypothenuse of a right-angled triangle, or what is the same in finding the length of a tunnel which rises or falls 1 in 4, or 6, or whatever it may be. The length per unit rise is measured as the horizontal distance and not along the slope; 1 in 4 means 1 rise for 4 horizontal.—ED.]

☞ Special Article next issue on "THE EFFECT OF ATMOSPHERIC CHANGES ON MINE VENTILATION," by WM. FAIRLEY, F.G.S., &c.

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Statistics of Coal Production and Consumption.

ACCORDING to a recent report by Sir Robert Giffen, issued by the Board of Trade, on statistics of the production, value, consumption, imports and exports of coal, the respective quantities produced by the principal coal mining countries in Europe for the year 1894 are, United Kingdom 188,277,000 tons, German Empire 76,741,000, France 26,964,000, and Belgium 20,534,000. The average value of the coal produced taken at the pit's mouth was in the United Kingdom 6s. 8d., German Empire 6s. 7½d., France 9s. 0½d., and in Belgium 7s. 5½d. Comparing the European countries with the United States it is stated that in the latter country the quantity of coal produced has in recent years increased distinctly, and indeed in the year 1893 it almost equalled the output of the United Kingdom, although in the year 1894 it shows some slight falling off. In the earlier years dealt with, viz., 1883-85, the average output of the United States was 103,000,000 tons; in the later years, 1892-95, it was 158,000,000 tons. During the same period the average value at the pit's mouth, which in the earlier years was 6s. 3d., fell in the later years to 5s. 3½d., or lower even than the cost in either the United Kingdom or Germany.

With regard to the production of coal in the British colonies and possessions, Canada comes first with an annual production of between 3 and 4 million tons. The output however, although increasing, is still insufficient for the requirements of the country, and considerable quantities of coal, amounting to about half the total consumption, are imported annually, chiefly from the United States. Next comes New South Wales, which produces annually 3¼ millions, but unlike Canada, the production has of late years remained stationary. In Victoria, Queensland, and Tasmania the production is unimportant, but in New Zealand over half a million tons is annually produced; as in New South Wales, however, the production is almost stationary. The Cape Colony produces only a small quantity, but in Natal the production, though small, shows considerable increase, the figures being in 1889, 26,000 tons, and in 1894, 141,000 tons. In British India the production in 1894 was 2,821,000 tons, showing a steady increase since 1883, when it was 1,316,000 tons.

The average value of the coal in these colonies was as follows:—New South Wales from 1883 to 1888 over 9s. a ton, in 1894, 6s. 4d. New Zealand averages over 11s. a ton; Canada, 9s. a ton; and in British India, 4s. 0½d. a ton.

The coal exporting countries are the United Kingdom, Germany, Belgium, and to a small extent the United States and Japan; whilst the British colonies which export coal are New South Wales and Natal. The following statement shows the exports for 1894 from the above-mentioned countries:—

EXPORTS OF COAL (1894).

	TONS.
United Kingdom	42,690,000
Germany	12,345,000
Belgium	6,263,000
Japan (1893)	1,536,000
United States	3,616,000
New South Wales	2,125,000
Natal	68,000

The countries which import coal in excess of the amount they export are Russia, Sweden, France, Spain, Italy, and Austria-Hungary, whilst the British colonies and possessions which do so are Canada, Victoria, Queensland, Tasmania, New Zealand, the Cape of Good Hope, and British India. The following statement shows the excess import of coal in each of the above-mentioned countries:—

EXCESS IMPORTS OF COAL (1894).

	TONS.
Russia (1893)	1,989,000
Sweden	1,984,000
France	9,571,000
Spain	1,824,000
Italy	4,682,000
Austria-Hungary	3,746,000
Canada*	1,946,000
Victoria	541,000
Queensland	11,000
Tasmania	39,000
New Zealand	33,000
The Cape of Good Hope*	115,000
British India	795,000

* Short tons of 2,000 lbs.

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The Arniston Collieries, Midlothian.*

By J. M. THOMSON.

(Continued from Last Issue.)

Pumping.—The water is pumped from two pits; it is not raised direct to the pit-head, but delivered into a clay level or conduit, which is connected with the surface at the Gore Burn, near Kirkhill Mansion House, 500 yards distant. The heaviest pumping engine is on the Emily Pit; it is direct acting and condensing, with an 80 inch cylinder and 12 feet stroke. The initial pressure of steam is 45 lbs., and there is a 25 inch vacuum. The water is raised in five forcing lifts, each lift being worked by a ram. Two piston rods are attached to the piston. A double set of pump rods are led down the shaft to three of the lifts. The size of these rods is 12 inch diameter, and they are made of pitch-pine.

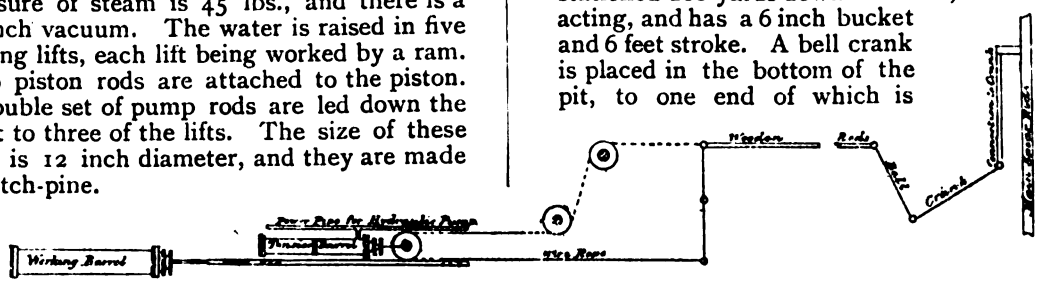

Fig. 4.

The following is a statement of the pumping arrangements in the shaft.:—

	No. of Lift.	Length of each in yds.	Diameter of Rods in ins.	Diameter of Rams in ins.
1	Top Lift pumping water for condensing	48	Two 12	14
2	Midset pumping to clay .....level	64	Two 12	16
3	Great Seam Lift	64	Two 12	16
4	Splint Lift.....	74	One 10	16
5	Parrot Lift	64	One 10	14

The weight in shaft is counter-balanced by three back balance beams attached to the pump rods. No. 1 beam is placed immediately below the crosshead connecting the pump rods to piston rods, is 35 feet in length, built of $\frac{7}{8}$ inch steel plates, and contains 20 tons of metal in box. No. 2 beam is at a depth of 60 yards, of the same size, and loaded with 16 tons of metal. No. 3 is 290 yards from the surface, of similar dimensions, containing 10 tons of metal. The speed of the engine during the last six months averaged fully $3\frac{1}{2}$ strokes per minute, which shews the quantity of water to be about 360 gallons per minute.

The water from the dooks is pumped in stages:—

1st.—By an attachment off the main pump rods in the shaft.

2nd.—By Hydraulic Power and Electricity.

3rd.—By Electricity.

4th.—By water chests or boxes during the period coal is not being drawn; the water being delivered into No. 3 lodgement.

No. 3 delivers into No. 2, and so on to the top. Provision is now being made at No. 4 Lift for the putting down of electric plant to pump the water, with enough surplus power to be used in haulage for the further development of the dook below this point, and, if necessary, for holing and drilling purposes.

First.—The chain pump as it is termed, of which a diagram is given, see fig. 4., is stationed 200 yards down the dook, is double-acting, and has a 6 inch bucket and 6 feet stroke. A bell crank is placed in the bottom of the pit, to one end of which is attached a pair of side rods connected to a pump rod working from an offset on the main pumping rods. On the other end is attached a pair of rods joined to a crosshead working in a pair of guides. The 6 inch pump rods are led down the dook on rollers for 100 yards, where they are connected with a chain to a "rocking tree" working vertical on a centre shaft, and built with $\frac{1}{2}$ inch steel plates. The chain is then led over a wheel 3 feet diameter, and down around a second wheel of the same size, when it is joined to a $1\frac{1}{4}$ inch wire rope leading down to the pump, and fastened to a chain similar to the top, and led round a third wheel. A rope joins this chain and bottom end of "rocking tree." The rod coming up from the pump is then attached to the chain, thus completing the connection and giving the reciprocating motion. Special arrangements are made for the keeping of regular and steady tension on the rope. The diagram, it is hoped, may be sufficiently explicit to make it understood. A pump barrel, 6 feet long, is placed above the pump and below the bottom wheel; the piston rod attached to the piston is working a crosshead in a pair of guides; to this crosshead the lower wheel is connected, and here advantage is taken of the power pipe conveying the water to drive the hydraulic pump at the 400 yards level,

* Extract from Journal of the British Society of Mining Students.

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by connecting an inch pipe inserted in the top end of the barrel to the power pipe, which gives 300 lbs. pressure per square inch on the piston, which obviates any jerky motion.

Second.—At 400 yards is placed one of Davis' hydraulic pumps, double-acting, 6 feet by 6 inches, the speed of which is $3\frac{1}{2}$ strokes per minute; a head of water is got 140 yards up the shaft. This lift is duplicated by a pump driven by electricity; the motor is four-poled, series wound, Victoria type, giving 500 volts and 20 amperes, which drives a 6-inch double-acting pump giving 18 strokes and 20 revolutions per minute, geared 1 to 8. The pump is capable, if necessary, of discharging the water from this lift direct to the pit bottom.

Third.—At 600 yards another electric pump, $4\frac{3}{4}$ inches diameter and 12 inches stroke, double-acting, forces the water up to the 400 yards level.

Fourth.—As before stated, the water from this stage is drawn by boxes during the period when coals are not being drawn.

The dynamo for the driving of these motors is a Manchester type, two-poled machine. The cables are $\frac{7}{16}$, lead-covered in shaft, and underground they are rubber-coated. This machine also lights the pit-head, engine rooms, and pit bottom.

Ventilation.—The Engine Pit is utilized as an upcast shaft; here is placed a 30 feet by 10 feet Guibal fan, developing 90,000 cubic feet of air per minute, with two inches of water-gauge, and is worked by a single-acting trunk engine with expansion valves, the steam being cut off at a third of the stroke. Cylinder, 24 inches, 36-inch stroke, and is going at 50 revolutions per minute. Naked lights are used throughout the whole colliery.

Systems of Working.—The Great Seam and Kailblades are worked stoop and room; sizes of pillars are 22 yards square; the places are driven 14 feet wide. No stooping has been done in any of these seams since the colliery began, the reason for which is that the Great Seam is immediately beneath the water-bearing strata, and it is considered that if stooping were resorted to, damage might be caused to the strata above to such an extent as to release the water and bring it down to a lower level. The Kailblades may be stooped by-and-by. The other seams are worked longwall, of which a reduced tracing is given from the original plan (see fig. 5), sufficiently, I trust, to make clear the system. When a new stage is to be opened up, the dook is driven down 8 feet wide; the ventilation is conducted by wooden rhones

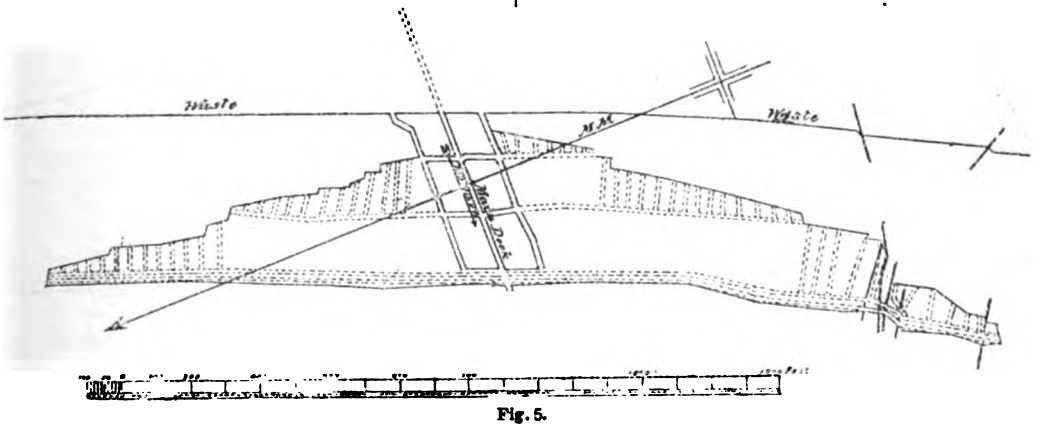

Fig. 5.

Old Engine Pit.—At this pit is a Cornish pumping engine, 44-inch cylinder with a 6-feet stroke, goes 4 strokes per min., working two sets of ram pumps. No. 1, or bottom lift, is at a depth of 220 yards. The top lift is placed at 130 yards from the surface, and discharges its water into the day-level 80 yards down the shaft. The rams are 14 inches diameter, and the quantity of water pumped is about 160 gallons per minute.

let down the one side; at 66 yards places are driven off at right angles to the line of the dook; these are carried in for a distance of 100 feet and then communicated with the levels above. This method is continued on until the 200 yards is reached, which is the full distance the dook is driven at one time. The main levels are here started on each side, as shown on plan; the lower level is meant as a water-course, the top one about six yards to rise as the main drawing road.

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This method is an advantage in the keeping of the main road, seeing that it is separated from the stoop with about nine yards of stowage; it will be observed that this allows the roof to subside more gradually on the main level. Owing to the steep gradient, the coal is all worked to the rise with 14-yard places. About two yards of the pavement is blown out to admit of the hutch being taken clear of the main drawing road. Two men generally work in one place, one man at at the face, the other engaged in filling and drawing the coals to the main siding, and the length of the shift is eight hours, commencing at six o'clock a.m., and finishing at two o'clock p.m. A stated rate per ton of 20 cwts. is paid to the miner; the drawer is paid by the miner at a fixed wage. The coal is filled with a "harp" as it is termed, something like a shovel, but having ⅜-inch round bars of iron 1¼ inches apart, to admit of the dross passing through; what is left on the harp, after being shaken, is considered round coal; this is placed into one hutch and paid at so much per ton; the dross is filled into another hutch and paid at a much less price. By this means the miner endeavours to obtain as much round coal as possible, which can only be done by the coal being properly holed. Occasionally, blasting of the coal is resorted to; the explosive used is ordinary loose powder, which is generally brought into the mine by the miher in a flask or canister made for the purpose, we, here, being exempted from the stringent rule laid down in the Mines Regulation Act. This system of working the coal to the rise has been carried on in Arniston for a very long time, and has always proved itself to be the most suitable method under the circumstances. The road taken up along with the face is usually about six feet wide; twelve to fifteen inches of "brushing" is taken out of the roof, which is adequate to pack the waste. The coal is generally shot down in "shoots" or "spouts" as the miners term them. These are made of sheet-iron and about 3 feet 6 inches wide by 12 inches deep; they are led up to the face as it advances, the coal is here thrown into them by the miner, and runs by gravitation to the bottom, when it is taken away by the drawer.

Brickworks.—In connection with the colliery and adjoining the Emily Pit, is a Brick and Tile Works. The material for making the fire-clay goods is got from the seam of fire-clay lying immediately at the bottom of the Kailblades Seam, which is of excellent quality. Composition bricks are made from the surplus "blaes" got in the re-brushing of the main roads, and any argillaceous matter found in the cleaning of the roadways. The plant in use is as follows:—One Fawcett brick-making and pressing machine, capable of making 8,000 bricks per day; one Hoffman continuation kiln, consisting of 10 chambers, each chamber holding 8,000 bricks; one Spencer sewage pipe-making machine, presses sockets from 4 inches to 12 inches diameter; machine for making flooring tile 9 inches to 12 inches; another Fawcett steam brick press, used for making different shapes and sizes of bricks; and one drain tile-making machine. There are also two round salt glaze kilns, three Newcastle kilns, and one small muffle kiln, used for enamelling purposes; with workshops where enamelled goods, gas retorts, and all sorts and descriptions of fire-clay wares are mauufactured.

Workshops.—The workshops are adjoining the Engine Pit, consisting of the usual joiners', blacksmiths', and engineers' shops, with verticals, lathes, punching and plate-bending machinery driven by steam; there is also a sawmill and gasworks in connection with the colliery.

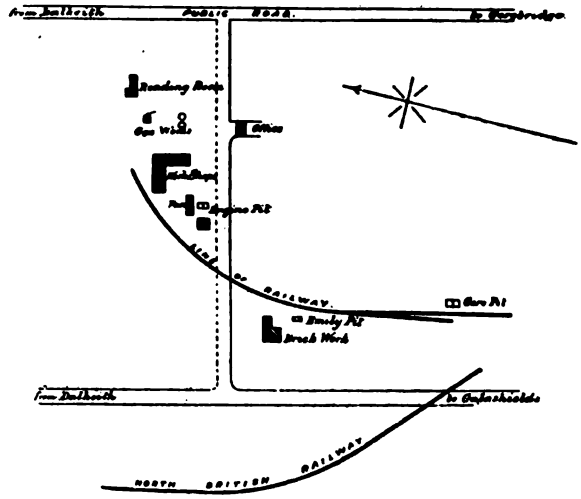

Fig. 6.

The Village.—The village of Hunterfield, which is principally composed of miners' houses, is prettily situated overlooking the valley of the Esk. The houses are mostly of very modern construction, consisting generally of from two to three rooms and kitchen, with conveniences, quite a contrast from many of the houses to be seen in colliery

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villages in many parts of the country. By the kindness of Mr. Dundas, of Arniston, and the Company, the men are provided with reading and recreation rooms; attached to these is a splendid bowling green, and lately, Mr. Dundas, at his own expense, built for the convenience of the workpeople a handsome wash-house and laundry, with all appliances suitable for such. For the villagers of Hunterfield and Gorebridge he provided also a public park and recreation ground, and many more deeds of kindness has he bestowed on the people of this district, which at this time it is unnecessary to mention, but which have made the name of Dundas a household word among the inhabitants of the Esk Valley.

The accompanying sketch (fig. 6) showing positions of the various places in connection with the works may be useful.

The Effect of Atmospheric Changes on Mine Ventilation.

By WM. FAIRLEY, F.G.S., &c.

(Specially written for this Journal.)

THAT changes of the weather have a prejudicial or beneficial effect upon the ventilation and sanitary condition of shallow mines there can be no doubt. The temperature and pressure of the atmosphere—the force and direction of the wind, all have an influence and produce an effect one way or the other. In these northern latitudes of our English mines a south wind has a bad influence, whereas, south of the equator, in the mines of the British colony of Victoria, when north winds prevail, evil consequences are the result. The prevalence of south winds and a low pressure of the atmosphere have frequently laid the shallow pits of South Staffordshire, and the adit, slope, or dipple workings of Dean Forest idle by accumulations of black damp, which take place under these conditions. Similar effects have likewise been noticed in some of the mines of Durham. Such bad effects, however, are noticeable only at mines where natural or furnace ventilation is in vogue, or where the artificial provisions instituted for the ventilation are imperfect. In mines ventilated by natural means it is common at some mines, by reason of the variation of temperature, for the air-current to go in one direction during the day, and in the opposite direction at night.

Old miners are well acquainted with the fact that a reduction of atmospheric pressure, or a southerly wind, in naturally ventilated mines, causes the appearance of black damp. If the normal atmospheric pressure at sea level be taken as equal to a column of mercury 30 inches high, a rise or fall of one inch effects the bulk of gas in a gob or goaf $\frac{1}{30}$th, so that by using a multiplier of ·0333 on a given quantity of gas, we get an amount additive or subtractive to that quantity on the variation of one inch. Thus 10,000 cubic feet of gas at 30 inches become 9,666 at 31 inches, and 10,333 cubic feet at 29 inches. This remark applies to mines nearly at sea level, with deep mines the case is somewhat different. The barometric pressure in a mine 300 fathoms deep will be two inches more than at the surface, hence the variation in the reading of the barometer will indicate a difference of pressure of $\frac{1}{32}$nd instead of $\frac{1}{30}$th, and the bulk of the gas will be increased or or decreased accordingly. This however is assuming that the first general rule of the Coal Mines Regulation Act of Great Britain is entirely ignored. In the United States it is enacted that all mines shall be kept free of standing gas (see for example the case of Kentucky, referred to at page 337 of *The Practice and Science of Mining Engineering*).

A reduction or increase in the atmospheric pressure as shown by the barometer does not signify an alteration in the ventilating pressure; but supposing it did, and we consider it in connection with an average case of the ventilation of an English coal mine, where the equivalent orifice is, say 30 square feet, and the quantity of air 100,000 cubic feet per minute, we find by making use of the co-efficient of ·0001672, given in the table at page 140 of the book just mentioned, that the pressure would be $100^2 \times ·0001672 = 1·672$ inches, an additional pressure of $\frac{1}{32}$nd would add ·05225 to this, making it 1·72425, then the quantity of air would be instead of 100,000

$$\frac{\sqrt{1·72425} \times 100000}{\sqrt{1·672}} = 101{,}556$$

being an increase of only 1½ per cent.; but the reasoning is fallacious, because the atmospheric pressure acts equally on both ends of the current, and therefore would not alter the amount of air passing.

The task of the mine ventilator is to circulate a sufficient quantity of air through all the openings, so as to render any accumulation of gas impossible, in fact he is legally bound to do this. His ventilating pressure must be entirely independent of natural causes, and one of the greatest factors necessary for the production of a copious air

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circulation is the area of the equivalent orifice, which is obtained by having roomy shafts and roads; but it must not be forgotten in connection with this question, that to lengthen the air passages—whilst fully maintaining their size—is equal to reducing the orifice, the area of which is in inverse proportion to the square root of the length of roads of the same section. To shorten the length of the air passages is tantamount to enlarging the equivalent orifice, which is likewise a result of splitting the air: and it must be remembered that the erection of a regulator, whether in the main current or in a separate split, has the effect of reducing the area of the equivalent orifice.

Gas is known to exist in solid coal or other rock at very great pressures, varying very much in different places; at a borehole in the state of Indiana for example, it issued at a pressure of 325 lbs. to the square inch, and at Boldon Colliery, in the county of Durham, it was found to exist in the solid coal at a pressure of 461 lbs. to the square inch. It might be supposed that the quantity of gas issuing from a coal seam would be dependent upon the pressure at which it exists in the coal, but according to the final report of the Royal Commission on Accidents in Mines, Great Britain, the rate of the outflow is not in proportion to the amount of the pressure. Considering this fact it appears beyond calculation what the rate of outflow would be under varying pressures of the atmosphere. Besides this, blowers of gas, both of firedamp and carbonic acid, come off quite suddenly, altogether independently of the atmospheric pressure, and this circumstance makes the matter difficult of calculation.

Changes of atmospheric pressure and temperature do undoubtedly affect the condition of the atmosphere of the mine when shallow and ventilated only by natural means, but so much cannot be admitted in the case of deep mines, the ventilation of which is now usually promoted under considerable pressure by mechanical means.

Meteorologists tell us that the critical time of danger is when the atmospheric pressure is at the period of change from low to high or high to low. Statistics show that colliery explosions take place under all conditions of the weather. Gas contained in the goaf is a far more sensitive barometer than mercury, which is 20,000 times (to be precise, 20,193 times) heavier than firedamp. Any warning founded on the records of barometric readings must be valueless, because the gas will come and go before any change is known to have taken place with the mercurial barometer. The French Firedamp Commission have said: "In our opinion it is proved that the variations of barometric pressure exert no influence on the disengagement of firedamp at the working face." The British Royal Commission say in their report: "The absence of a general connection between colliery disasters and barometric changes is practically established." The conditions of gas bottled up in a goaf, and that which is contained in the solid coal, are very different. It has been seen that the rate at which it may flow from a working face is beyond calculation; and the writer is not aware that the engineer can do anything either to hasten or retard its rate of flow. The only thing that can be done to destroy its harmfulness is to have a constant stream of air passing along the coal-face. The gas in a goaf will act like a barometer and move in and out as the atmospheric pressure increases or decreases; but it is unlawful to have a cavity containing a body of gas walled in, the cavity must be either filled up or the space ventilated by passing a current of air through it. The writer in his experience has known several cases where explosions have taken place through putting in air-tight stoppings at the end of blind roads, or erecting scaffolds on the top of jacky-pits, such excavations should be either ventilated or tightly stowed with debris.

No doubt the provisions made by general rule 33, of the Coal Mines Regulation Act, that a barometer and thermometer shall be placed above ground in a conspicuous position near the entrance to the mine is a wise one, but as regards changes of atmospheric pressure the ventilation officials can tell us that the indications of gas are always in advance of the movements of the mercury, and no wonder, when it is remembered that the same variation in pressure represented by a difference of three inches in the reading of the barometer would theoretically be indicated by 5,000 feet of firedamp.

The utility of colliery warnings may well be questioned, for although it must be admitted that weather forecasts are made on thoroughly scientific principles, and based on actual facts as to atmospheric movements at places considerably distant, by noting the direction from which changes are approaching, and the nature and speed of the changes, they cannot be reduced to an exact science. Even if a storm warning proved to be correct in every case, it cannot, by changing the name into a colliery warning, be considered applicable to those deep and fiery mines which

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are ventilated by passing large volumes of air through spacious galleries under great pressure produced by means of mechanical ventilators. In such a case neither the direction or force of the wind at the surface, or an altered atmospheric pressure, should interfere with the effectiveness of the ventilation. If the ventilating engineer is specially careful when he receives an admonition from the meteorologist, he may be led into indifference in the absence of it, and therefore the wisdom of heeding such warnings may be doubted. As bearing on this subject we may quote the words of the well-known and accomplished mining engineer of Lancashire, Mr. Henry Bramall, M.Inst.C.E., who says: "In what state does firedamp exist *in situ*? And what are the effects of varying atmospheric pressure upon its liberation? And is the barometer of any value as a warning of coming danger? These are questions which early attracted attention, and have been much discussed. Mr. Wood has carried out a most extensive series of elaborate and careful experiments to ascertain the conditions as to the solid coal, and Mr. Corbett has rendered a similar service in respect of goafs, and the conclusion seems to be in both cases that the barometer affords no reliable indications when to expect danger from gas in a mine."

Although the occurrences of rumblings and emissions from volcanoes, which have taken place on certain changes of the weather, may indicate a direct relationship to barometrical pressure, it does not follow that we are to expect a greater flow of firedamp from the coal-face in mine workings under similar conditions, indeed, such a connection has not been established.

What should be the constant care of every miner? To prove the mine properly ventilated and to see that the air-current through every ramification of it is sufficiently vigorous to place the question of its safety beyond the range of meteorological vicissitudes; single-handed the colliery manager cannot attend to all the details of doing this, especially in collieries where miles of air-passages are open, but in imparting his wishes to his subordinate officials, he should be qualified to direct that duty to be done.

It would be an interesting question for miners to explain why more colliery explosions occur on Mondays than on the other days of the week, why explosions are more prevalent in winter than in summer, and why firedamp, as it appears to the writer, is keener or more fierce on a cold winter night than at any other time of the year.

The Engineering of Collieries,

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

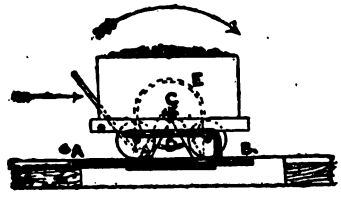
By T. A. O'DONAHUE.

(Commenced in No. 9, Vol. III., continued from No. 7, Vol. IV.)

TIPPLERS.

THE machine by which the coal is discharged from the banking stage to the screens is known as a tippler. The chief ends to be attained in the construction of a tippler are facility and speed in working, and in manœuvring the tubs, with a regular discharge of coal, and a minimum of breakage. Tipplers are classed into three kinds, viz., forward, back and side, according to the manner in which the minerals are discharged.

Fig. 62.



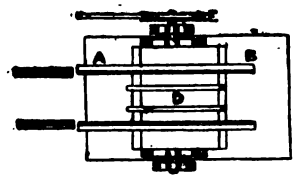


Fig. 63.
Elevation and Plan of Forward Tippler.

Forward Tipplers.—This is the oldest form of tippler, the coals being discharged in the same direction as the tub enters. In its simplest form it consists of two short lengths of rails (A B figs. 62 and 63) connected to a base plate or cross bars, and suspended by journals from an axis (c). A pair of stop forks project over the axles of the tub and hold it in position whilst tipping. When the full tub is put into the tippler, the centre of gravity of the whole is above the axis of the tippler, and the centre line of the load is a little beyond the centre of the tippler. The natural tendency, therefore, is for the tub and tippler to fall forward and discharge the coal from the tub. When this has taken place, however, the centre of gravity is again above the axis of the tippler, as the greater weight now lies in the wheels, axles, &c., and the consequence is that the tippler turns

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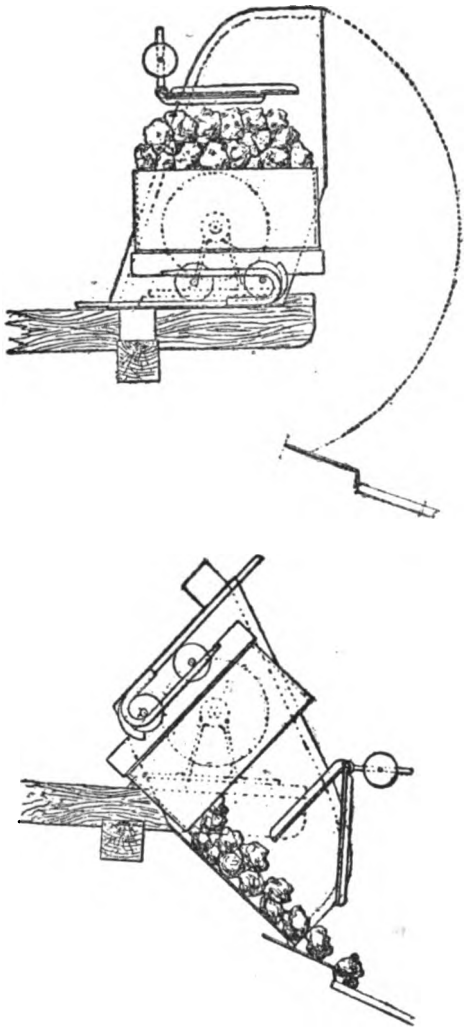
back into its original position. To regulate the motion of the tippler to some extent, and to prevent the coals being discharged too precipately, a brake is attached to the wheel E. The lever handle of the brake is held by the attendant, and the rate of discharge is governed as required.

The principal objection to tipplers of this class is that the coals have a considerable distance to fall on to the screens, thereby causing breakage of the coal and a large amount of small.

Figs. 64 & 65.



Rigg's Forward Tippler.

Rigg's Tippler (figs. 64 and 65) greatly remedies this defect, and is certainly the best form of forward tipplers in use. The principal of action is the same as that of the tippler first described, but the tippler is enclosed on three sides by a hood of iron plates, the back portion of which forms a shoot for the coals while discharging. As will be seen from the illustrations the shoot drops directly on to the screen, and forms what may be said to be a continuation of it, so that the coals have not to drop on to the screens but simply slide down from the shoot. After considerable experience in the use of this tippler, it was found, that when the operation of tipping was quickly performed, there was a tendency for a quantity of coal from the back elevated end of the tub to be thrown forward by centrifugal force past the end of the shoot, thus partly defeating the object of the shoot. To prevent this a horizontal balanced door is now fixed in the tippler a little higher than the top of the tub, the coal being thus retained in the tub until the shoot has been lowered almost to the screen. This tippler is in use at many collieries in the United Kingdom.

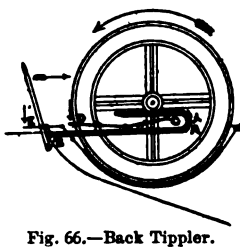


Fig. 66.—Back Tippler.

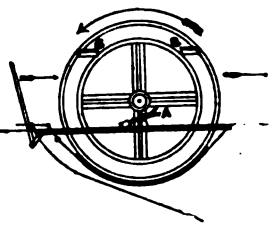


Fig. 67.—Back Through-way Tippler.

Back Tipplers.—The great distance through which the coals are discharged on to the screens in the forward type of tippler led to the designing of the back tippler. By this tippler the tub is turned inwardly, and the coals are deposited at the top of the screen. As the screen may be fixed to allow only a small clearance for the tub, the distance through which the coals drop is greatly reduced. The ordinary form of back tippler is illustrated by fig. 66. It consists of two large wheels connected together by rods, and provided with a suitable floor, thus forming a kind of cage into which the tub is placed. The tub passes into the tippler in the direction shown by the horizontal arrow, and is prevented from passing through by the stops A. The tippler revolves in the direction shown by the curved arrow, but is supported by the keps B while the tub is being put in and out. The keps are withdrawn by the lever, the tippler falls backward through part of a revolution, discharges the coals and assumes its original position on the same principle as described in the forward tippler. The tub is held in position during the operation by the

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catch C, which allows the first axle of the tub to pass over it, but prevents it from coming back until the bar D is depressed after the revolution, and thus allows the tub to be removed. The speed of the revolution is controlled by a brake on one of the large wheels worked by the lever E. With the tipplers above described considerable loss of time is occasioned in manœuvring the tubs as they have to be taken out of the same end of the tippler at which they entered. The construction of the through-way tippler (fig. 67) renders this unnecessary. The tub passes into the tippler at the same end as in the one previously described, but when the first axle bar of the wheels has passed over the lever catch A, the attendant arrests the passage of the tub, the keps are withdrawn and the tippler turns backwards and discharges the coals from the tub. The tub is held in position during the operation of tipping by the catch A, which holds an axle of the tub, and by the brackets BB, which project over the sides of the tub. When the coals have been tipped and the tippler assumes its first position, the next full tub pushes the empty one from the tippler and takes its place.

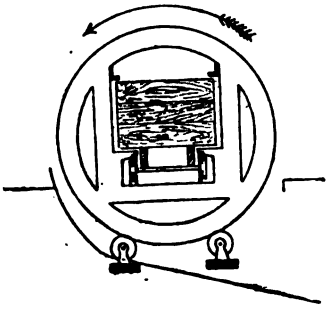

Fig. 68.—Side Through-way Tippler.

Side Tipplers.—These tipplers have been introduced with a view to remedy to a greater extent than is possible in the other forms, the disadvantages which have been pointed out. Colliery tubs are always constructed with the greater length along the side, and therefore tipping from the side instead of at the end gives greater area of discharge, slightly lowers the centre of gravity of the load of coals (when lowered for tipping), thus reducing the average distance through which the coals have to fall, and deposits the coal upon a greater screening area. It is also more efficient for passing the tubs through, and is now most commonly used. Fig. 68 shows the general construction. It consists of two hoops of iron which form the ends of the tippler instead of the sides as in the back tippler. These circles are connected by iron plates, and the whole rests on four grooved bearing wheels two under each hoop. The tippler rotates on these bearings instead of on an axis, and the principle of the movements is the same as in the other tipplers, the centre of gravity changing its position with respect to the centre of rotation after the coals are discharged. The tub is held in position during rotation by the brackets over the wheels. There is also a slight indent in the rails in the tippler where the wheels rest, in order to prevent the tub passing through the tippler, unless considerable force is applied. The tippler may be made to turn a complete revolution or be turned back after emptying the tub.

(*To be continued.*)

Correspondence.

CORRECTION.

Sir,—In your issue of the 7th inst., I notice that in my solution *re* tunnelling, there is a mistake in finding length of tunnels. Whether it is an error in copying from MS., or an error on my part, I am not prepared to say, nevertheless the error is there. The solution makes out the *hypo* of the triangle to be greater than the sum of the *base* and *prop*. The solution should be

$$\sqrt{(50\times 4)^2+50^2} = \sqrt{200^2+50}$$
$$= \sqrt{42{,}500} = 206 \text{ practically.}$$

By inserting this correction at your earliest convenience you will oblige. ——— JAMES SKIPSEY.

GEOMETRICAL PROBLEM.

Sir,—If you can afford space in your little paper for the following, I would esteem it a favour:—Show by *geometrical construction* the exact position of two trees, *A* and *B*, which are situate as follows: *A* stands *inside* a square field at a distance from corners *a*, *b*, *c*, of 150 yards, 250 yards, and 350 yards respectively. *B* stands *outside* a square field at the same distances from corners *a*, *b*, *c*, as *A*. Prove by Euclid that the construction is correct, and find by trigonometry the length of one side of the field in each case. J. SKIPSEY.

[Half-a-crown will be awarded for the best answer to the above problem.—ED.]

SURVEYING AS A VOCATION.

Sir,—I would be much obliged if you could supply me with the following information through the columns of your valuable journal:—In order to hold the position of colliery surveyor does it require the person in charge to hold a certificate on mine surveying? What are the wages usually paid for a head surveyor and for an assistant surveyor? Trusting you will favour me with the information. SURVEYOR.

[The City and Guilds of London Institute hold an examination yearly on mine surveying, but it is not compulsory for surveyors to pass any examination whatsoever, and in consequence comparatively few possess a certificate. As to the wages which a surveyor generally receives we cannot say, as the latitude in price is too great to admit of a definite answer. Perhaps some reader could oblige, however.—ED.]

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Answers to Competition Questions.

GIVEN IN No. 6, VOL. IV.

SIZE OF VENTILATING FAN AND ENGINE.

(1) Give description of the kind and size of ventilating fan you would erect to produce 200,000 cubic feet of air per minute, and the size of engine to drive it, &c. Effective steam pressure 30 lbs.

Ans.—The data required for the calculation of the dimensions of a centrifugal fan to be applied to the ventilation of a mine are the volume and water-gauge; but in the question given we must assume either the w.g. or the probable equivalent orifice—the latter can be got from the following formulæ:—

Where A = equivalent orifice in sq. ft.
" Q = quantity in cu. ft. per min.
" H = height of water-gauge.

$$A = \frac{\cdot 0003736 \times Q}{\sqrt{H}}$$

I will therefore assume that the equivalent orifice = 36 square feet, which from the desired quantity of 200,000 cubic feet per minute means a w.g. of 4·3 ins. approx.

According to Prof. Merivale a good idea of the appropriateness of a fan for the ventilation of a mine can be got by the ratio A ÷ O, where A is the equivalent orifice of the mine, and O the orifice of discharge of the fan, both terms being in square feet. If the value so obtained is equal or greater than unity, the fan would be too small for the resistance of the mine, but if the value is less than unity, then the orifice of the fan may be considered as being fairly proportional to the requirements of the mine, and when the ratio falls to ·4 then this may be safely taken as representing a fair working ratio. The required ratio of A ÷ O being then ·4, the required orifice of the fan will be—

$$\frac{A}{\cdot 4} = \frac{36}{\cdot 4} = 90 \text{ sq. ft.}$$

From tables compiled by Prof. Merivale we find that a Guibal fan having an orifice of discharge of 90 square feet would be 35 feet diameter (approx.). The size of fan therefore would be 35 feet diameter, having an orifice of discharge of 90 square feet (Guibal); but we must also find the velocity of the fan to produce the desired volume and water-gauge. The speed of the rim in feet per second to produce the desired results is determined by the formulæ—

Let x = speed of rim in feet per second.
Q = quantity of air in cu. ft. per min.
A = equivalent orifice of the mine.
O = orifice of the fan.
K = a fraction representing the maximum manometric efficiency realised by the fan; this taken as 0·6.

$$\text{Then } x = \frac{Q}{40}\sqrt{\frac{A^2 + O^2}{2K \times O^2 \times A^2}}$$

$$= \frac{200000}{40}\sqrt{\frac{36^2 + 90^2}{2 \times 0{\cdot}6 \times 36^2 \times 90^2}}$$

$$= 5000\sqrt{\frac{1296 + 8100}{1{\cdot}2 \times 1296 \times 8100}}$$

$$= 5000\sqrt{\frac{9396}{12597120}}$$

$$= 5000\sqrt{\cdot 0007458} = 5000 \times \cdot 0273 = 136{\cdot}5$$

Therefore the speed of the rim must be 136·5 feet per sec., and the number of revolutions made by the fan:—

$$\frac{136{\cdot}5 \times 60}{35 \times 3{\cdot}1416} = 74{\cdot}5 \text{ revs. per min.}$$

I would have the fan coupled direct with the engine, the speed of the piston therefore would be 74·5 × 2 = 149 multiplied by length of stroke in feet, the useful effect in the air being:—

$$\frac{200000 \times 4{\cdot}3 \times 5{\cdot}2}{33000} = 135{\cdot}5 \text{ H.P.}$$

The power required to circulate the desired volume might be 135·5 × 1·65 = 223·575 I.H.P., or say engine of 225 indicated horse-power, to allow an ample margin.

SUMMARY.—Fan, 35 feet diameter (Guibal), making 74·5 revolutions per min., this being of sufficient size and speed to maintain the desired quantity with a 4·3 in. w.g. I would have a pair of engines in case of accident, etc., each engine being approximately of 225 I.H.P., the size of engine being:—Diameter of cylinders, 24 inches; length of stroke, 4 feet; average steam press., 30 lbs. per sq. in.

Engines and fan of the above dimensions will be sufficient for the purpose of maintaining the required conditions. J. SKIPSEY.

VENTILATION.

(2) How much more resistance does an air-current encounter when travelling at 600 feet per minute, then at 500 feet per minute. Size of airway being unchanged. If the W.G. is 0·76 at the lower velocity, what would it be at the higher?

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Answer.—The rule is that the frictional resistance varies directly as the square of the velocity, consequently if we increase from 500 feet to 600 feet per minute the resistance would be in the following proportion, thus—

$5^2 : 6^2 :: 0{\cdot}76 : 1{\cdot}09$ inches of W.G.

Therefore it would meet with—

$$\frac{1{\cdot}09}{0{\cdot}76} = 1{\cdot}43$$

or nearly 1½ times greater resistance, and the W.G. would be 1·09 inches at the increased velocity. THOMAS WATSON.

COLLIERY SURFACE ARRANGEMENTS.

(3) Give a brief description with sketch or sketches of what you consider to be a good arrangement of surface works for a colliery with two shafts, fitted to wind 2,000 tons per day.

[NOTE.—There was only one answer worthy of publication, but the sketches were so crude and incomplete that it was impossible for our draughtsman to make a suitable reproduction, and the consequence is, the sender loses the award. Those competitors who are unable to make sketches suitable for publication should at least make them sufficiently clear to enable a proper copy to be made.—ED.]

Competition Questions.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before April 3rd, 1896.

We invite readers to forward questions for this competition.

(1).—Describe the working of a Mine with which you are acquainted. Give sketch or sketches of a portion of the Mine, and shew method of ventilating same.

(2).—If three workable seams of coal occur in water bearing strata at equal distances apart, and within a depth of 20 yards, in what order would you work the seams, assuming the roofs to be similar in character? State your reasons.

(3).—You have a 9 feet seam of coal, with a fair roof, and only 1 foot of rubbish to work by longwall, the depth of the seam being 400 yards. Shew how you would work it, and explain your reasons why.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—James Skipsey, 25, Co-operative Terrace, Newsham, Northumberland.

Commended.—T. Hill, Crosby Villa, by Maryport, Cumberland; J. Laverick, Butterknowle, County Durham; T. Watson, 3, East Hedley Hope, Tow Law; G. McDonald, 29, Crosby Villa, Maryport; E. G. Scotney, 44, Byron St., Hucknall Torkard, Notts; W. Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.; T. E. Aitchison, Green Hill, Dunaskin, Ayrshire; J. W. Nelson, Normanby Mines, Normanby, Middlesbro.

Question 2.—Thomas Watson, 3, East Hedley Hope, Tow Law.

Commended.—T. Worthing, Dukestown, Tredegar, Mon.; W. Musgrove, Winning Newburn, R.S.O.; W. Bent, Hayfield Cottage, Plains, Andrie, Lanarkshire; J. T. Day, 33, Castle Street, Hindley, near Wigan; J. H. Clarke, 576, Morton, nr. Alfreton; W. Young, 345, Syndale Hall Cottages, Bolton Road, Bolton; G. Daykin, 24, High Gurney Villa, near Bishop Auckland; J. Halbert, 17, Arthur Street, Hebburn Colliery, Durham; T. Webster, 7, Birchley Road, Billinge, near Wigan; H. Hall, Whneli Terrace, Woodland, Butterknowle, County Durham; R. Wardle, West Wylam Colliery, Newcastle-on-Tyne; W. H. Turton, 18, South Row, Newfield, Chester-le-St., Durham; J. W. Nelson, Normanby Mines, Normanby, Middlesbro.; J. E. Keefe, Amble, Northumberland; R. Derbyshire, 45, Kearsley Street, Daisy Hill, Westhoughton; G. Paisly, Vaults Lane, Kilwinning, N.B.; T. Lawrenson, 269, New Boston, Haydock, Lancs.; G. Black, 35, Canal St., Kirkintillock, by Glasgow; A. Ratcliffe, 61, Catlow Hall St., Oswaldtwistle; G. McDonald, 29, Crosby Villa, *via* Maryport, Cumberland; J. Peet, 4, Green Lane, Orrell; T. E. Aitchison, Green Hill, Dunaskin, Ayrshire; G. W. Hedley, Medomsley Edge, Medomsley, R.S.O.; W. Mycock, New Silksworth, *via* Sunderland, County Durham; E. G. Scotney, 44, Byron Street, Hucknall Torkard, Notts; J. W. Evans, near Brynsty, P.O., Prenton, Broughton, near Wrexham; J. T. Hall, Holy Moor House, Corkfield, *via* Darlington, Durham; G. Taylor, Audley Street, Knotton, nr. Newcastle-under-Lyne, Staffs.; W. Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.; T. Hill, Crosby Villa, Maryport, Cumberland.

Question 3.—(No award).—*Commended.*—J. P. Atkinson, 55, King Street, Hoyland, near Barnsley; Wm. Slocombe, 11, Thorne Avenue, Newbridge, *via* Newport, Mon.; J. E. Keefe, Amble, Northumberland; A. North, 31, Brown Street, Pontrobank, Merthyr; T. E. Aitchison, Green Hill, Dunaskin, Ayrshire; W. B. Forster, Tudhoe Colliery, Spennymoor; J. H. Berry, 36, Chatsworth Street, Walkden, near Bolton.

Any information respecting Advertisements in this paper will be given on application to the "THE MANAGER," Advertisement Department, "Mining" Office, *Clarence Works*, Wigan.

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Answers to Correspondents.

T. E. A.—MS. received. Shall have our due consideration.

CURIOUS.—With refereuce to the controversy between "A Democratic Pitman" and ourselves in the *Wigan Observer*, no answer appeared to our second letter. The four letters reprinted in *Mining* comprised the whole of the correspondence. Our last was evidently too much for him.

Literary Review.

THE PRACTICE AND SCIENCE OF MINING ENGINEERING. A manual adapted for the use of Mine Owners, Mining Engineers, Colliery Managers, Mine Foremen, Mineral Surveyors, and Practical Miners. By W. Fairley, Ph.D., F.G.S., Mining Engineer, Certificated Colliery Manager, author of "The Colliery Manager's Calculator," "The Colliery Manager's Catechism," "The Theory and Practice of Ventilating Coal Mines," &c. Published by James Fairley, Shafto House, Chester-le-Street, Durham. Price 21s.

The work consists of some 366 pages, 119 figures, and numerous tables. The author has adopted the now very popular method of "question and answer," The questions are over 1,000 in number and are arranged in ten chapters, as follows:—Geology; the properties of minerals, their mode of occurrence, and methods of prospecting for them; practical mining operations; the properties of air and gases, and tbe principles of mine ventilation; the mechanical work performed by pneumatic machines in the ventilation of mines; mechanics; wire and wire ropes, their characteristics, uses, &c.; mining arithmetic and mathematics; land and mine surveying; miscellaneous subjects. Throughout the book are found a large number of questions that have been given at recent examinations in mining for the colliery manager's or mine foreman's certificate of competency, and mine inspector's qualification in the different districts of Great Britain, New Zealand, Nova Scotia and the many districts of the various States of North America where coal mining is in operation. It will thus be seen that a considerable amount of original information on mining work in foreign countries is supplied—a task for which the author's extensive and world-spread experience specially adapts him. The questions are fully and—as may be expected from the author of so many standard works—excellently answered. To the end of each chapter is appended a bibliography of the principal works dealing with the subject of the chapter. The author remarks that a perusal of the chapters on pneumatic machines, wire and wire ropes, prospecting for minerals, and the special information disseminated throughout the other chapters, will be evidence of originality of a good deal of the information, and with this we entirely concur. Mr. Fairley puts in a handy form a number of important tables, which will make the work extremely useful for reference. We reprint a few of the questions and answers to give some idea of the manner adopted in completing this excellent work.

Q.—What measures would you adopt to decrease the liability of gob fires? (Inspector Des Moines, Ex.)

A.—As gob fires occur with large bodies of fine coal, I would prevent the crushing of the coal, when pillar and stall working is practised, by having the pillars sufficiently large. When longwall mining is operated, I would avoid any accumulation of small coal in the gob, which should be tightly stowed with stone, and would advance the face of working as quickly as possible, so that the coal at the face would not be crushed; because it is known by experience that beds of coal, liable to spontaneous fire, are most subject to it when trade is slack, and the mine is worked intermittingly.

Q.—How much coal per acre is there actually obtained in mining coal?

A.—As a rule, the greater the thickness of the seam the greater is the proportion of loss in working it. From the coal seams of the Northumberland and Durham coalfield 1,000 tons per inch per acre is the quantity calculated to be obtained—no doubt in many cases more is obtained. From the six feet seams of Cannock Chase it is generally reckoned that 1,000 tons per foot thick per acre are gotten In working the very thin seams of Somersetshire, in some cases as nearly as possible the whole pit is obtained. Of the Dudley Thick coal, 30 feet thick, it is generally understood that only about half of it was gotten. In the year 1893, a State Commission appointed to investigate the waste of coal mining in the anthracite regions of Pennsylvania issued a preliminary report in which they based their estimates on an average that for every ton produced 1¼ additional tons are lost, so that only 40 per cent. of the coal is got there. When the specific gravity of the coal is 1·25 the number of tons in an acre is 1,519 per foot thick; for any other specific gravity the quantity may be found by proportion.

Q.—What is the ordinary size of fans in use for mechanical ventilation.

A.—The Rateau fan, so far as the writer knows, has been made of two sizes, namely, 6·56 feet by ·52 feet, and 9·18 feet by ·754 feet. The Capell fan is made of various diameters, 8·23 feet, 10 feet, 12·5 feet, and 17·5 feet. In the examples enumerated the diameter of the Guibal varies from 30 feet to 50 feet, and the Waddle from 28·81 to 45 feet, one example only of this latter size of the Waddle having as yet been erected, which is at South Moor Colliery, Durham.

[Since writing this the writer finds that several 45 ft. Waddle fans are now erected in different coalfields.]

Q.—How many revolutions a minute will a fan run safely?

A.—The smaller fans will make the largest number of revolutions most safely. In the examples quoted in the table at the end of this chapter, the Schiele, 7·33 feet diameter, has made the most revolutions (400), giving a top speed of 111 feet per second. On this subject A. L. Steavenson says: "If a 36 feet fan runs at 70 revolutions per minute, it is as much as any fan will safely run,"—Transactions of the North of England Institute of Engineers, vol. 18, p. 139. This is equal to 133·6 feet per second.

Q.—Can an explosion happen when no one is in the mine?

A.—I believe it is possible for firedamp to be ignited from the fire caused by the friction of stones in rubbing against each other in a large fall from the roof.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 10. Vol. IV. April 4th, 1896.

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Safety Explosives in Germany.

A REPORT has been presented to the Home Secretary by Mr. Henry Hall and Mr. Joseph Martin, Inspectors of Mines, on the visit they paid to Schalke, in Westphalia, in October of last year, to investigate the experiments conducted there by Herr Bergassessor Winkhaus. The report contains a description of the experiments, and is illustrated with photographic productions.

An experiment was carried out at the suggestion of the inspectors to test whether a local wet roadway in an otherwise dry and dusty mine would prevent the extension of the coal dust explosion in that direction. The floor of the gallery was covered with coal dust (9 lbs.) for a distance of 9 yards from the cannon or working face, the next 9 yards was thoroughly wetted on roof and sides, and contained water varying from 3 to 6 inches in depth, and the rest of the gallery to the outlet end was covered thinly with dust. A charge of 7 ounces of gelatine dynamite was fired, with the result that the flame of the dust explosion travelled 8 or 9 yards beyond the wet portion of the gallery, and so far as could be judged, their was no material difference in the result than from others where similar charges were used without the intervening water. The report states:—whether it will be possible to limit the extension of coal dust explosions by artificially wetting local lengths of roadway in each section of a colliery can only be decided by extended experiment and further inquiry.

Some experiments were also made with a view to satisfy the inspectors that the detonators used to fire the shots were of sufficient strength to ensure complete explosion of the charge, and they had no hesitation in stating that a No. 6 detonator, such as used throughout the earlier experiments of Herr Winkhaus, was ample in strength.

In the list of explosives, which appear in the tabulated experiments, it is said that "Favier" may be taken to correspond with Ammonite—"English Carbonite" with carbonite; but that Roburite 1 does not appear to correspond with English Roburite. The other English explosives, such as Bellite, Electronite, and Ardeer Powder, were not represented in the experiments. It was seen that two or three of the explosives experimented with stood out as exceptionally safe. These were German Coal Carbonite, Roburite 1, and Dahmenite A. With the first and second no ignitions were recorded; Dahmenite A gave off considerable flame with a charge of 19¾ ounces, and with a charge of 25 ounces there was a voilent explosion of the gas and dust. German Coal Carbonite was tested to 29¾ ounces, and Roburite 1 to 26¾ ounces without failure. The comparative strengths of the explosives differ widely however, German Coal Carbonite being represented by 232, Roburite 1 by 358, and Dahmenite A by 502, so that the charge of 19¾ ounces of Dahmenite A was equal or thereabouts to the charge of 23¾ ounces of Robourite 1, and both these were considerably stronger than the charge of 29¾ ounces of German Coal Carbonite. German Coal Carbonite appeared in Herr Winkhaus' earlier experiments, and is the only explosive which has no failure recorded against it, the only approach to failure being referred to as "very feeble shimmer of light at the first window." It was found that the fumes from this explosive were more powerful and apparently more noxious than from any of the others. Westphalite withstood the tests applied to it during their presence, but it appears to have frequently failed in the earlier experiments.

They proceed to state that the Newcastle experiments differed in one important particular from those made in Germany, viz., that

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the charges of explosive used seldom exceeded 2½ ounces, whilst in Germany charges of 30 ounces were used, and on this account the German trials might be taken as more conclusive.

Whether any of the explosives now procurable possess all the necessary qualities, an extended use in the mines alone can show, but so far as this country is concerned English Roburite may be said to have withstood this test successfully.

In conclusion they submit that these experiments again prove, if further proof were needed, that the use of certain safety explosives instead of such explosives as gunpowder, dynamite, &c., would substantially diminish the risks of blasting operations in coal mines. Legislation with this object should not only specify the kind of explosive, but should also place a limit on the amount of charge, and forbid ignitions except by electricity. They strongly recommend that even safety explosives should be used, accompanied by one or other of two alternate safeguards, either they should be used between "shifts" or the vicinity of the shot should be made damp by copious watering. To enable the authorities to decide which explosives can be properly classed as safety explosives, a testing station will be required, and this station, they suggest, should be controlled by Her Majesty's Inspectors of Mines, in conjunction with Her Majesty's Inspectors of Explosives.

With regard to the second question, which they were instructed to investigate, viz.: To what extent safety explosives have taken the place of gunpowder in German mines, they report as follows:—Gunpowder is entirely forbidden in mines representing 80 per cent. of the total production (40,000,000 tons) of Westphalia. The prohibition of gunpowder has been in operation during the past four years, and is applied to all mines subject to firedamp and dangerous coal dust, and blasting at or near the coal face in such mines may only be carried out with "safety explosives" or certain other explosives, such as ghur dynamite, blasting gelatine and gelatine dynamite, so used with water or other contrivance as to be safe. In such mines blasting in stone tunnels or stone work at a distance from the coal face may be carried out with flaming explosives, such as dynamite, but in no case with gunpowder. In mines without firedamp, blasting with gunpowder or any flaming explosive is forbidden in any place which is dry, or where dust of an inflammable nature exists. In all cases before firing a shot of any explosive, it must be proved by careful examination that there is no accumulation either of firedamp or dust within a distance of 10 metres. The other usual precautions with regard to blasting, such as proper tamping, handling, &c., have to be strictly observed. The safety explosives most generally in use in German mines are Dahmenite A, Westphalite, and Carbonite. The effectiveness of these rules to prevent explosions has been materially diminished by the fact that up to this time charges of safety explosives have been fired by tape fuse with the order that only the highest class of such fuse should be used and the result has been not infrequent explosions of dust or firedamp. We are informed that it is now intended to forbid the firing of safety explosives, except by means of an electric battery. Safety lamps are compulsory in all seams in which firedamp has been found. The system of Government inspection is much more elaborate than in England, but whether it is practically more effective seems doubtful. In Germany we find one inspector for every 6,000 workmen, whilst in England the proportion is one for every 20,000. The mineral raised per life lost in German mines is about 100,000 tons, and in England 170,000 tons. This large difference may be due to the presence of greater natural difficulties in continental mines, but another cause may be a system of inspection, which by attempting too much becomes saddled with a responsibility for the management of the mines which ought to rest with the officials. We submit, in conclusion, that a return should be obtained showing to what extent safety explosives are already in use in England with a view to their compulsory and general adoption as already suggested, so that the whole of the collieries may be required to attain an equal standard of safety.

SUBSCRIPTION RATES.

We will forward our journal, post free, to any part of the United Kingdom, America, France, Belgium, Canada, Austria, Germany Spain, Italy, Russia, &c., at the following terms:—

Twelve Months -	**3s. 6d.**
Six Months - -	**2s. 0d.**
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Midland Institute of Mining Engineers.

A GENERAL MEETING of the members of this Institute was held on Saturday, March 14th, at the Queen's Hotel, Leeds, when Mr. JOHN NEVIN, president, occupied the chair.

ADJUSTABLE PISTON RINGS.

Mr. H. WORMALD read a paper on "Adjustable Piston Rings," in the course of which he premised that the object of a piston ring is to prevent slip of steam or water past the piston when working, to keep the piston at its full duty, and to prevent waste of steam. Engineers knew that piston rings became defective after working some time according to the pressure exercised against them or against which they are forcing. Spring was usually allowed for in piston rings that they might move outward to fit the body of the cylinder as they become worn, but very frequently they did not move out as desired, or as theoretically allowed for, and hence some means of adjustment was required to make them fit the body of the cylinder. This adjustment the Wormald ring possessed, and it remained in as effective working order when almost worn out as when new, having besides the additional advantage of wearing the cylinder bodies equally at all parts of the circumference. A system of outer, central, and packing rings was used, which formed one solid block after setting in position. There was no possibility of the main piston rings being compressed inwards, as they rested upon the packing rings, but they could move outward in the same manner as rings of any other type. He showed how the outer rings when worn were placed inside, and so on until the last of the rings was worn, when they were replaced in the usual way. They had been practically tested, and gave results far superior to those obtainable where engines were working with piston rings having no adjustment.

In the course of a subsequent discussion, Mr. WORMALD said the rings were not expensive, and with an ordinary engine working twelve hours a day would last a couple of years. Several objections and criticisms were made and answered, and the discussion was closed.

MINING EXPLOSIVES.

A short discussion took place on Professor Lewes' paper on "Mining Explosives."

CLOSING THE TOPS OF UPCAST WINDING SHAFTS.

Mr. Alex. Reid's paper on "Methods of Closing the Tops of Upcast Winding Shafts" was further discussed. Mr. Reid advocates a system whereby the cage ascending enters, at the top of the shaft, a kind of wooden box, self-acting doors closing behind it, so that the ventilation is not interfered with.

Mr. BONSER said where apparatus of this kind was employed safety hooks were not used in some cases, because it was said that the continual passage of the catch through a small space rendered the catch liable to act before its time.

Mr. HARGREAVES (Thrybergh Hall Colliery) and Mr. ROUTLEDGE (Garforth Colliery), who had had a system similar to that advocated by Mr. Reid in use for several years, said they had never found the slightest difficulty or danger in connection with the safety hook. The door for the hook and shackles, &c., was a light one and travelled up with the cage, not in any way touching or interfering with the hook. Mr. Hargreaves added that at another pit, where the winding shaft was used as an upcast, they had not this arrangement, but the banking was done in an air-tight chamber away from the pit mouth, which they found a very costly and troublesome business.

ELECTRICAL MACHINERY FOR MINES.

A paper by Mr. RANKIN KENNEDY on "Electrical Machinery for Mines" was discussed. Mr. Kennedy showed how the adoption af polyphase current machinery was likely to have an important effect on the use of electrical machinery in mines, largely increasing its utility and enabling a much wider distribution of power to be made without waste or danger.

TELEPHONIC COMMUNICATION IN MINES.

The question of "Telephonic Communication in and about Coal Mines" was afterwards considered in a paper by Mr. A. W. BENNETT.

CHESTERFILD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS.—A general meeting of the members of this institution will be held in the Municipal Science College, Green Lane, Derby, to-day, Saturday, the 4th April, at 3 o'clock p.m.

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Forced Draught for Steam Boilers.

THE use of forced draught is now becoming general, not only in the mining districts but by steam users in various trades all over the Kingdom. It will, therefore, be of interest if we explain briefly what are the advantages to be derived from its adoption, these are (1) the boiler will produce more steam owing to the greater intensity of the fire; and (2) the cheapest fuel, such as common slack, coal dust, and refuse fuel generally, can be readily burnt, so that the cost (expressed in money and not in the weight of fuel consumed) of raising steam is greatly reduced. In the case of boilers working under average conditions both these objects are simultaneously secured, but in other cases it is necessary to carefully distinguish under what condition these advantages are to be respectively attained. In order to explain the subject clearly we will take

TWO EXAMPLES FROM EVERY-DAY EXPERIENCE.

First, there is the over-worked boiler, burning probably a coal of fair or good quality, yet unable to maintain steam for efficiently running the colliery, more especially at certain times, or when the weather is unfavourable to the furnace draught. The natural draught may be sluggish or of only medium strength, and in such cases a good system of forced draught will so stimulate the fires that the output of the boiler will be increased to the extent of 20 to 25 per cent., the same quality of coal being used as before. The coal, however, may with advantage be small, or in the form of slack, in which state it is usually cheaper than when large. Now it should be carefully noted that, in the foregoing case, where the boiler has to be worked to its utmost capacity, a common fuel of low heating power is not desirable, and often not even admissible, as it would probably fail to give the required volume of steam, though, owing to its cheapness, it would reduce the cost of whatever steam might be produced. Sometimes more or less common fuel is mixed with good coal, and the two are burnt together. Take now the second instance, viz., that of a boiler which is only moderately worked, but where it is desired to produce steam at the least possible expense. In this case the cheapest slack, coal dust, or even general refuse, may be burnt by the aid of forced draught, which, owing to its power, produces a very intense fire and a complete combustion, thus enabling the same amount (and often more) of steam to be raised as with the previous natural draught and good coal, costing perhaps three or four times as much. The actual saving effected in this way varies a great deal in different districts, in some of which the inferior fuels are very cheap and abundant; while in others the cost is either comparatively high or they are not easily procurable; but striking a rough average, there is a saving of some 40 to 50 per cent. in the cost of raising steam. There are of course other and incidental advantages arising from the use of forced draught, such as the ease with which its power may be adjusted to suit the varying demands on the boiler, independence of the chimney draught, easy clinkering, preservation of the fire-bars (in steam jet systems), etc. Having thus described the general advantages of forced draught we will proceed to explain the details of a system which is in extensive use throughout the manufacturing and mining districts, and which is known as Granger's Forced Draught Furnace. The illustration (fig. 1) shows Granger's Forced Draught as applied to a Lancashire boiler. It will be seen from the illustration that the mouth of the ashpit is closed by an iron plate or cover A, through which pass two blowers BB, projecting some little distance into the ashpit. At the outer end of each blower is fixed a blowing nozzle or steam jet D, these being connected to a steam supply pipe E. When in operation the steam jets force large volumes of air through the blowers BB into the ashpit,

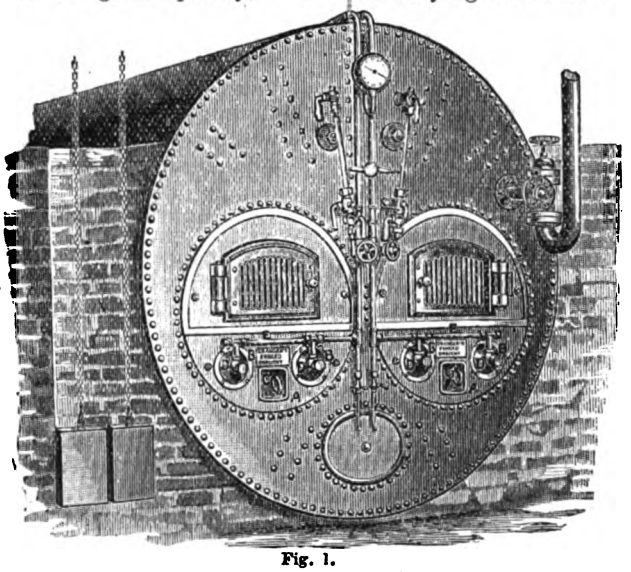

Fig. 1.

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which at once becomes a species of air reservoir, the pressure being diffused equally throughout the ashpit. The air then forces its way through the small spaces between the fire-bars and among the fuel, the combustion of the latter being so greatly stimulated that its full heating power is actually brought out and utilised for making steam. The door C is for raking out the small quantity of ash which falls through the fire-bar spaces, these spaces being very much narrower than used in furnaces under ordinary draught only. So great is the stimulating effect of the blast upon the fires that three boilers will often produce as much steam as four will do with only natural draught, and the increase is always more marked in cases where the natural draught is sluggish. Compared with a fair natural draught the increase is about 25 to 30 per cent.

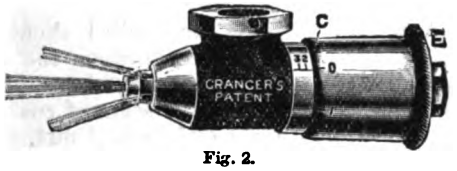

Fig. 2.

As the blowing action is entirely produced by the steam injecting nozzle, it is of great importance that this should be a really efficient apparatus in order to reduce the steam consumption to a minimum, and after numerous experiments the nozzle shown in fig. 2 was designed and patented. It will be seen that in addition to the central jet there are three others surrounding it, which can be readily adjusted in area by merely turning the milled rim E, the adjustment being defined and facilitated by graduations C on the body of the nozzle. Special attention is called to this facility of adjustment, as by its means the stoker can with the greatest ease regulate the strength of the draught up to about three times its normal power if necessary, no matter whether there be 10 lbs. or 100 lbs. of steam pressure in the boiler and nozzle, or what the condition of the fuel, the requirements of steaming, or the state of the natural draught. This blowing nozzle is an entirely new departure in steam jets, and it has been most favourably received by eminent engineers. Formerly, nozzles have generally been controlled by a cock or valve, which merely throttled the steam and thus greatly impaired the impact of the jet, upon the energy of which its efficiency so much depends. Another method of obtaining an adjustment of power is by the use of annular or ring-shaped jets, which can be made larger or smaller by moving a tapered plug in the mouth of the nozzle, thus causing the annulus to vary in size. This, though a simple arrangement, is fatal to economy of steam, and it has been proved by several experiments that annular jets of the proportions used for forced draught are greatly inferior in steam economy to solid jets, consuming, as they frequently do, nearly double the weight of steam for the same duty. The small quantity of steam from the injecting nozzles becomes thoroughly mixed with the air and is subsequently decomposed, thus actually assisting in and promoting the combustion of the fuel. Experiments have proved that not a trace of water or even moisture can be found in the ashpit after many hours of continuous work. The manufacturer of the above two patents is Mr. W. A. Granger, 102, Brooke Road, Stoke Newington, London.

EXAMINATION QUESTIONS,

WITH ANSWERS BY

J. CARTER, First-Class Certificated Manager.

Questions given in the South-Western District, Sept., 1894, for Under-Managers' Certificates of Competency.

(The figures in parenthesis show the number of marks obtainable.)

(Continued from No. 8, Vol. IV.)

No. 2 Subject—VENTILATION.

(60 marks to qualify.)

Q. 4.—How would you satisfy yourself that the ventilation is adequate in a naked light mine? (20)

ANS.—In the first place I should examine the mine thoroughly with a safety lamp and ascertain the nature of it to see whether it was liable to any outbursts of gas at any time, or a mine in which inflammable gas had not been seen for over 12 months. If these conditions were favourable then I should consider myself satisfied as to all appearances of safety and should consider the ventilation adequate for such a mine when after such an examination had been made I found all parts of the mine free from gas and a good current moving through it. But to my mind naked lights in mines ought to be abolished, because the circumstances in mining are variable and almost constantly changing. Therefore, a mine may be safe for a naked light one moment, the next the reverse may be the case, owing to the sudden appearance of CH_4, which at times has made its appearance from various causes, even in mines which

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have been hitherto free from gas.

Q. 5.—What effect has carbonic acid gas or blackdamp on mixtures of firedamp and air? (20)

Ans.—The effect that CO_2 has when mixed with firedamp and air is that it renders the mixture less explosive and lights burn dull and sluggish, and as the CO_2 increased the light would gradually diminish until the proportion of CO_2 would become so great that lights would be extinguished, whereas in mixtures of firedamp and air it becomes more and more explosive, 1 of gas to 9·4 of air.

Q. 6.—Would you expect the air of a mine to contain more moisture in warm weather or in cold weather? State your reasons. (20)

Ans.—I should expect to find more moisture in the air of the mine in warm weather, because the greater the temperature the greater the quantity of moisture which the air can contain. Air at a definite temperature cannot contain more than a definite quantity of moisture or aqueous vapour, and if this maximum, which is known as the "dew point" or point of saturation is reached, a decrease in temperature is followed by a condensation of a portion of the vapour held in the air. The air may, however, be heated above the saturation point, a circumstance which often happens in warm weather, and it is then prepared to support a further quantity of vapour if available, or to decrease its temperature to some extent without any condensation. Whereas in cold weather the air is often at its saturation point and a slight decrease in temperature is immediately followed by a condensation of the vapour. This is the reason why cold generally feels damper than warm air, although it may contain less moisture.

No. 3 Subject—PRACTICAL MINING.

(120 marks to qualify.)

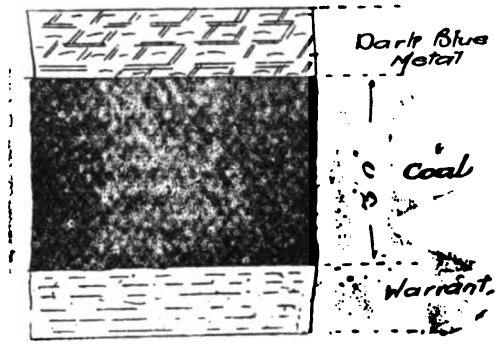
Q. 1.—Sketch a section of a coal seam in your district and describe the best manner of dealing with the top and bottom in the stall or wagon roads in the seam you refer to. (20)

Ans.—The section here given is of a mine which I have been acquainted with:—

Roof (dark blue metal)	2 ft.
Coal	3 ft.
Floor (dark warrant).....	1 ft.

(*See sketch.*)

In dealing with this mine in the stalls or wagon roads the roof was ripped down and the debris packed in the waste to form roadways. In addition to this the floor, which



varied from 1 ft. to 1 ft. 6 in., was holed in by the colliers and stowed behind them for packing their places. With the existing conditions we found this to do very well.

Q. 2.—In working the longwall system what would guide you in deciding the best distance between the stalls or wagon roads? (20)

Ans.—In working longwall I should be guided as to the distance between the stalls or wagon roads by considering the nature of the mine. For instance, a seam of coal may be divided by a layer or layers of dirt, therefore the thickness of such would have to be taken into account so that roads could be placed so far apart as to hold its own dirt in the waste. The nature of the roof and floor of a mine must also be considered. With a moderate hard roof and floor I have found from 12 to 15 yards a fair distance between stalls in mines having from 1 ft. to 1 ft. 6 in. of dirt parting between the seam of coals.

Competition Questions.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "Competition," and to reach us before April 17th, 1896.

We invite readers to forward questions for this competition.

(1) Assuming you was asked to fire a shot in coal, the holing being 3 feet and the shot hole 3 feet 6 inches, what would you do?

(2) You have a level plane 200 yards long, over which it is proposed to construct a railway. It is required to raise the embankment 2 yards above the level plane at one end and 5 yards at the other; the top of the embankment is to be 20 feet wide and the slopes 1 in 1. Calculate the cubical contents of the earth required for the embankment.

(3) You have a seam of coal, 4 feet thick, 200 yards deep, with a soft wet floor and with a shaley roof 2 feet thick, which falls. Describe with sketch how you would work it.

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Coal Cutting Machines.*

A Summary of Mr. R. M. Haseltine's Experiments.

By H. F. Bulman.

THESE experiments, recently published, are of special interest, as shewing the *power* used by coal cuttting machines when undercutting coal, in a number of instances and over a considerable area.

Mr. Haseltine, a Chief Inspector of Mines, made observations on twelve separate machines in seven collieries situated at various points in three of the most important coalfields in the State of Ohio, U.S.A. Of the machines five were Jeffrey bar machines, and the other seven were chain machines—four Jeffrey, two "Independent," and one "Morgan-Gardner." They were all driven by electricity, the tension of current being about 220 volts. Meters were inserted in the circuit near the machine, and their readings registered every 15 seconds whilst the undercutting was proceeding. The volts and ampères being known, the actual H.P. developed was readily calculated.

The hardest coal cut was at the Congo Colliery in Perry County, and here, at the same mine, a Jeffrey bar machine, a Jeffrey chain machine, and an Independent chain machine were all tested under equal opportunities. The hardness of the coal is apparent from the fact that the knives or cutting chisels had to be renewed ten and twelve times during a shift. The operators manufacture their own knives, the cost of which has been estimated at 2½ cents per ton† of round coal produced. At this time the Jeffrey bar machine was tested whilst making five cuts, each 5 feet 6 inches deep by 2 feet 8·4 inches wide, equal to an area undercut of 14·8 square feet. The time occupied averaged 4 minutes 31 seconds for each cut; the maximum H.P. averaged (on the five cuts) 26·9, the minimum 17·3, and the average 22·7.

The Jeffrey chain machine was also tested over five cuts at the same mine, each cut in this case being 5 feet 9·6 inches deep by 2 feet 7·2 inches wide, equal to an area undercut of 15 square feet, nearly the same as the former. The time occupied averaged 3 minutes 37 seconds; the maximum H.P. 17·2, the minimum 12·3, and the average 14·5.

The Independent chain machine also made five cuts, each 6 feet 2 inches deep by 3 feet 3·6 inches wide, equal to 20·4 square feet. Time occupied averaged 3 minutes 29 seconds; maximum H.P. 22, minimum 14·1, and average 18·1.

27 H.P. may therefore be taken as about the maximum power likely to be required in undercutting coal by a rotary bar machine; this coal being, as already stated, of exceptional hardness. The difference in the power required by the machines is striking, the Jeffrey chain machine doing the same work as the bar machine with 8 H.P. less expenditure of power.

Taking the whole of the experiments at the seven collieries, the five bar machines consumed (on an average over the number of cuts made) 18·7 H.P., and the seven chain machines 14·4 H.P.

The power required to overcome the frictional resistance of the machine (that is to start the machine when not cutting coal) averaged, with the bar machines, 6·85 H.P., and with the chain machines 4·22 H.P., leaving the net average H.P. consumed in cutting the coal 11·8 with the former, and 10·2 with the latter. Reducing the terms of comparison to the common denominator of one square foot undercut in one minute, the five bar machines used, on an average, 10·1 H.P., and the seven chain machines 6·4 H.P. Deducting the power expended on the frictional resistance of the machines, these figures become 3·2 H.P. and 2·2 H.P. respectively. The power expended by the same machine undercutting in the same seam at the same mine, varied greatly, the variation in one instance being from 10 to 30 H.P.

As regards ease in working and economy of power, these experiments show the advantage of the chain machines.

With reference to the produce of coal and the cost of getting it by machines in comparison with pick mining, the data about reciprocating machines appear to be more abundant than about rotary bar and chain machines.

Produce of Coal.—With reciprocating or projectile machines, as Mr. Haseltine calls them (such as the Ingersoll-Sergeant or the Harrison) the undercutting is done in much the same way as with the pick, being made about 18 inches thick in front and diminishing to a few inches at the back, and the produce

* Extract from Journal of British Society of Mining Students.

† The ordinary method of calculating costs at these American Mines, as described in Mr. Haseltine's paper, is on a ton of 2,000 lbs. of lump or round coal, which is equivalent to about 3,000 lbs. of unscreened (run of mine) coal.

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of round coal is much the same in both cases, as might be expected. Thus in a seam 4½ feet thick, with pick mining the proportion of round produced was 65 per cent., and with the reciprocating machine 66 per cent., and in another instance, in a 3½ feet seam, the proportion with the pick was 72·4 per cent., and with the machine 70·8 per cent. In the 4½ feet seam the daily output with the reciprocating machine was 28 tons round coal, or 42½ tons unscreened, and the area undercut 170 square feet daily. In the 3½ feet seam the daily output was 21¾ tons round, equal to 30·7 tons unscreened, and the area undercut 168 square feet.

With the rotary bar and chain machines the thickness of the undercut is only a few inches (5 inches) throughout, and the coal got in the cutting is practically lost. The amount of small coal is therefore less than with pick mining. In one instance the figures are as follows:—

Lbs.	Machine.			Pick.		Lbs.
2000	Lump Coal,	72	per cent. ..	66	per cent.	2000
347	Nut ,,	12½	,, ..	14	,,	424
42	Pea ,,	1½	,, ..	6	,,	182
389	Slack ,,	14	,, ..	14	,,	424
2778						3030

That is, for every 2,000 lbs. round coal, 778 lbs. small are produced at the same time by the machine, and by pick mining 1,030 lbs. small, or 252 lbs. more. With the reciprocating machines, as already stated, the results are practically the same as with pick mining.

Cost.—With reference to the cost, Mr. Haseltine gives the following figures, calculated per ton of unscreened (run of mine) coal filled into tubs in the working face, the ton being the weight of coal got in producing 2,000 lbs. of lump or round coal.

The cost is exclusive of the power driving the machines.

	No. 1 Instance.	No. 2 Instance. (taken over two years.)
	s. d.	s. d.
Reciprocating Machine ..	27·7c. = 1 1·8	.. 29·7 = 1 2·8
Pick Mining	39c. = 1 7·5	.. 43·5 = 1 9·7
		s. d.
Rotary Bar and Chain Machines ..	29·7c. = 1 2·8	
Pick Mining	39·6c. = 1 7·8	

These figures show a saving in favour of the machines of about 6d. a ton in getting the coal. From this, however, should be deducted the cost of the power, which in one instance of reciprocating machines driven by compressed air, the only instance given, is estimated at 5c. = 2½d. a ton.

Progressive Expansion Gear for Winding Engines.

AT a meeting of the North Staffordshire Institute of Mining and Mechanical Engineers some time ago, Mr. WOODWORTH submitted a paper on the patent progressive expansion gear fitted to a pair of 36in. winding engines at Sneyd Colliery, by Messrs. Cowlishaw and Woodworth. It was stated that in designing expansion gear for winding engines, it was necessary to provide for conditions totally different from those applicable to ordinary engines. In the first place, it was necessary to provide for starting freely under maximum loads; secondly, the gear should be so designed that no loss of speed was experienced, otherwise the advantages of expansion would be lost; thirdly, the expansive working should be put into operation at the earliest possible moment in the wind, and be so proportioned as not to cause any reduction in the speed. He gave a detailed description of the gear and the result of the working of the same up to the time his paper was written.

Mr. COWLISHAW at a recent meeting now contributed a supplementary paper showing more clearly the advantages of Mr. Woodworth's device. He said a complete wind consisted of 29 revolutions of the engine, and steam was only admitted for 21 revolutions, the remaining 8 being run by momentum. With the winding engine working under ordinary conditions, steam was cut off in each revolution at about 0·85 of the stroke, allowing but 0·15 of the stroke for expansion. With the Woodworth gear in operation, for four revolutions steam was admitted for about 0·85 of the stroke, the gear then coming automatically into operation, commencing at the fifth revolution with a cut-off of about 0·40 of the stroke, and at the twenty-first revolution cutting-off at about 0·20 of the stroke. The actual amounts of steam used for a complete wind were as under:—Where the gear was not in operation, 2,376 cubic feet; where the gear was in operation, 1,435 cubic feet, showing a saving of 40 per cent., or 941 cubic feet. The actual economy as measured in the fire-hole was the saving of the labour of one fireman out of three. The period of winding a complete run, including banking, was 1 min. 13 secs. This result for an engine winding from a depth of 1,863 feet, with three-decked cages, each landed sepa-

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rately with two tubs on a deck, was no doubt good work. The actual running time averaged about 54 secs., the piston speed for 7 secs. or 8 secs. during the fastest period of the run being as high as 720 feet per minute, while the cages were travelling at the same time at the rate of about 43 miles an hour. The application of the Woodworth gear had not increased the time of winding. Recently the Woodworth gear was removed for slight alterations; and in consequence of this the daily output of coal was approximately 100 tons less than usual. No stronger testimony as to the merits of the Woodworth gear could possibly be adduced.

An interesting discussion followed the reading of the paper, and it was understood that further efforts would be made to ascertain the actual saving effected by the new gear. The discussion was therefore adjourned.

The Use of Petroleum in Safety Lamps.*

By Mr. E. B. WAIN.

ALTHOUGH the use of petroleum underground in open lamps has been universally condemned, there appears to be no reason why this class of illuminant should not be more largely used with a suitable burner in a locked safety lamp. The light given is better and the cost of the oil consumed is reduced very considerably. Since the report of the Accidents in Mines Commission in 1886, it has been the custom to use a mixture of colza oil and petroleum in varying proportions, and no doubt many of the so-called "safety lamp oils" (the preparation of which was supposed to be a trade secret) were composed of such a mixture. In practice the writer has found that a mixture of four parts of pure colza oil to three parts of Russian petroleum having a flashing point of about 100 degrees Fahr., makes the most suitable mixture for use in Marsaut and Mueseler lamps with a flat wick $\frac{5}{16}$ in. wide. The Mines Commission recommended that the petroleum used should not have a lower flashing point than 80 degrees Fahr., and if care is taken that the oil is of the proper quality, there should be no danger whatever in the use of petroleum in mixed oil. There seems to be no reason why petroleum should not be used exclusively if the lamps and burners are suitable for the illuminant. The results of some experiments made by the writer with various patterns of burners are as follows:—

Lamp.	Burner.	Oil.	Time. 80z. charge.	Wick.	Comparative Illumination	Cost per ten hours.
			Hours.	Round.		d.
Mueseler	Kaye	Petro.	11	¼in.	1·20	·076
				Flat.		
Ashworth-Mueseler	Ashworth	Do.	9	¼in.	1·53	·082
Mueseler	H. & F.†	Do.	11	¼in.	1·45	·076
Marsaut	H. & F.†	Do.	11	¼in.	1·48	·076
Marsaut	Plain	Do.	9½	¼in.	1·53	·090
Marsaut	J. C. M. ‡	Do.	9½	¼in.	1·48	·090
Marsaut	Ashworth	Do.	12	¼in.	1·71	·070
Marsaut	Barton	Do.	10	¼in.	1·71	·084
Thorneburry short type	Barton	Do.	8½	¼in.	2·20	·099
Marsaut	Plain	Mixed	11¼	$\frac{5}{16}$in.	1·00	0·19
Mueseler, Belgian	Plain	Do.	13	$\frac{5}{16}$in.	0·93	0·15

The mixed oil was four parts colza and three parts petroleum.

The lamps with petroleum burners were all inferior in illuminating power to those with ordinary colza oil burners, and the quantity of petroleum burnt was approximately in proportion to the illuminating power of the lamp. The Thorneburry lamp, fitted with the Barton burner, gave the best light.

With regard to gas testing with a safety lamp burning petroleum, a smaller percentage of gas can be detected than with an ordinary lamp.

† Heath & Frost ‡ Johnson, Clapham, & Morris.

* Extract from paper read before the North Staffordshire Institute of Mining and Mechanical Engineers.

PENNSYLVANIA ANTHRACITE STATISTICS FOR 1895.—In the eight anthracite districts of Pennsylvania the total production during the past year was 51,207,007 tons, which was an increase of 5,356,005 tons on the previous year's output. The number of persons employed was 143,610, the number of fatal accidents was 422, as against 445 in the previous year, and 1,120 non-fatal accidents against 925 in the previous year. The details of the accidents are as follows:—

CAUSE OF ACCIDENT.	No. of Accidents. Fatal.	Non-Fatal.
Explosions of gas	31	164
Falls of roofs and sides	191	374
Falling down slopes, shafts, etc.	14	6
Explosions of powder blasts, etc.	59	145
Crushed by wagons, machinery, etc.	66	243
Miscellaneous	61	188
Totals	422	1120

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Answers to Competition Questions

GIVEN IN No. 7, VOL. IV.

WORKING AN OUTCROP SEAM OF COAL.

(1) Describe with suitable sketch how you would work an outcrop seam of coal 4 feet thick, dipping 1 in 4.

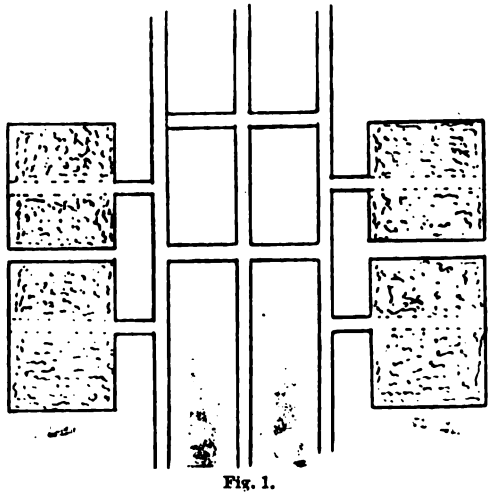

Fig. 1.

Answer.—In working out such a seam we must first of all take into consideration the following points because of the inclination of the mine from the outcrop or "basset edge" of the seam:—(1) The area of royalty. (2) The nature of the over-lying strata (even at the thickest or lowest point of such royalty). (3) The surface conditions respecting buildings, rivers, railways, etc. (4) The nature of the coal, strong or tender. Now these points will greatly aid the management in deciding where best to sink the shafts from the area of such field, also the best mode to work such seam. I have worked in a seam 3ft. 9in. thick on the east side of the Yorkshire coalfield, where the seam was cropping out to the surface. The seam was moderately strong, but the cover was very tender and porous and the surface ground wet and swampy, the seam dipping on an average 1 in 4. The shafts were put down a mile and a half from the outcrop and were only 30 yards deep. At this point the seam came practically level, and the mode of working adopted was the pillar and stall. The main winnings were driven out to the boundary, a few bords opening out from the two back levels as shown in fig. 1. These bords were widened out eight yards from each place, that is four yards on the left side of the tub road and four yards on the right side, and holing at intervals, leaving a thin rib of coal between until the sides were gobbed up tight. The holings acted as ventilators for the stalls. There was always plenty of dirt for stowing these places up (fig. 2). Timbering was seldom required as the colliers bridged their places (see sketch), always leaving from 3 in. to 5 in. of top coal. No doubt this would mean a large amount of coal lost, but there was less timber used and the men could work with much more safety. The coal was worked from the lower to the rise, which was the best and most economical method to adopt.

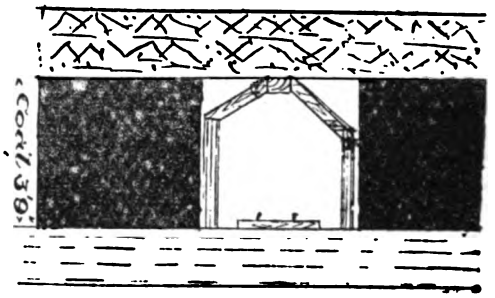

Fig. 2.

SAMUEL DAVIES.

METHOD OF WORKING.

(2) Two pits are 80 feet apart, the deeper shaft being 300 yards, seam of coal 5 feet thick, gradient 1 in 6, dip coal to be hauled by engines into the bottom and not interfere with rise haulage, stoop and room working—show doors, stoppings and air-crossings, and position of engines, and four or five stoops to dip and rise and bottom pillars, coal to be raised from both shafts. Give sizes of all pillars. (Award doubled for this question.)

Answer.—In working this seam of coal on the stoop-and-room system I should first start out two levels, one from each pit, about 4 yards wide and 20 yards apart, and connected by cross-cuts every 40 yards for ventilation. When these levels had been driven about 70 yards from the pit on each side, I should start a pair of dips down, going about half-dip, about 20 yards apart and 3 yards wide, and connected the same as before for ventilation. When the dips had been driven down 50 yards I should drive a level stoop right across and thirl through to the other pair of dips. After this I should turn levels every 40 yards and also start headings every 40 yards off them, so as to cut the coal up into pillars 40 yards wide. I should have engines

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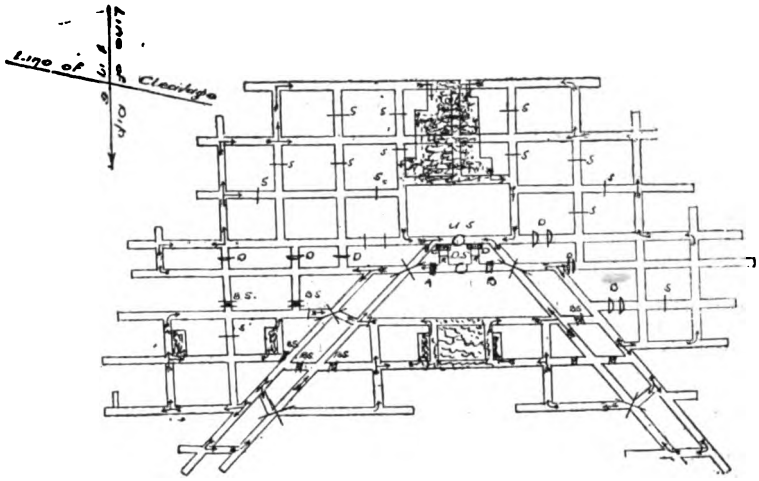
fixed at A and B, to haul the coal out of these dips. At the rise side of the pit I should drive a heading up, starting about 20 yards past the dips and turn levels off every 40 yards so as to cut the pillars as before. I should fix a pair of main and tail rope engines an each side of the upcast shaft to draw the coal along the levels; the coal being brought down to the levels by self-acting inclines. The level stoops should be driven about 3 yards wide and the rise stoops about 5 yards if the roof was fairly strong, and the coal would be taken off from these pillars in lifts or rooms, about 5 to 8 yards wide, according to the strength of the roof, the road being formed on the side of the coal and protected on the other side by a gob-wall. I should leave a pillar against the shaft, 100 yards wide along the level course of the seam and 130 yards on the dip course. Against the levels and dips I should leave a pillar 20 yards wide on each side. The direction of the air-current is shown by arrows. I should wind all the coal from the upper level and headings up the upcast shaft (U S), and all from the lower level and dips up the downcast shaft (D S). A. NORTH.



Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Samuel Davies, Barrow Farm, Worsbro., near Barnsley.

Commended.—J. Craggs, Butterknowle, Darlington; J. McDonald, Crosby Villa, Maryport, Cumberland; J. E. Keefe, Amble, Northumberland; W. E. F. Leadbetter, 82, Front Row, New Bolsover, near Chesterfield; Chas. E. Greene, South Durham Colliery, Eldon, Bishop Auckland; Jas. Laverick, Butterknowle, County Durham.

Question 2.—A. North, 31, Brown Street, Pentrebach, Merthyr-Tydvil.

Commended.—Thos. Watson, 3, East Hedley Hope, Tow Law; J. E. Keefe, Amble, Northumberland; R. Wardle, West Wylam Colliery, Newcastle-on-Tyne; S. Davies, Barrow Farm, Worsbro., near Barnsley.

Answer to Correspondent.

ALEX. BAILIE (Newton).—Shall be obliged for copies of the examination questions you name.

Colliery Extension in Ayrshire.

The Auchenharvie coalfield, near Stevenston, Ayrshire, has been worked at intervals for over 200 years, and the workings in the well-known Turf seam now extend for more than half-a-mile under the sea. Some two years ago the Glengarnock Iron and Steel Company, Limited, the lessees of the colliery, in view of the rapid extension of the workings seaward, considered it advisable to arrange for the concentration of both the winding and pumping operations. A new vertical shaft was at first proposed, but as trials soon showed that a new sinking through the sandhills would bring in a large quantity of surface water, it was decided to proceed with a daylight mine as an outlet for the coal, and to concentrate pumping operations at their No. 5 pit. The tunnel is 9ft. wide and 7ft. 6in. high, and, starting with an incline of 1 in 4½, extends 750 yards to the bottom of No. 5 pit, and thence for 800 yards to the working faces at an inclination of 1 in 8. Through this tunnel all the coal from No. 5 pit will be conveyed to the surface by the endless haulage system. The daylight mine is really a continuation of the dook workings. When the tubs arrive at the top of the dook they will be hauled up the daylight mine by means of an endless rope. The tunnel is formed of brick, with arched roof and manholes at short intervals; and the rails and sleepers are of steel, laid on fine slag. Messrs. A. Barclay, Sons and Co., Kilmarnock, have supplied for the works a compound surface condensing engine with high-pressure cylinder 16in., and low pressure, 28in. diameter, and 3ft. stroke. The high-pressure cylinder is fitted with Turnbull's automatic expansion gear, and the low-pressure cylinder with Meyer's variable expansion arrangement. The gearing is of cast steel, the pinion on engine shaft having 26 teeth by 4½in. pitch, and the spur wheel on countershaft having 68 teeth by 4½in. pitch. The winding drum or pulley which is for endless rope is also of steel, and is keyed on a vertical shaft, which is also geared by bevil wheels of steel, having 26 and 28 teeth respectively. This drum is fitted with a powerful brake. The piston rod stuffing-boxes are fitted with Barclay's patent "silverine bronze" metallic packing rings, and generally the engine is well-finished, and a substantial

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piece of workmanship. Arrangements have been made to duplicate the engine as the works extend underground and more power is required. Messrs. Penman and Co., Glasgow, have supplied two Lancashire boilers, 30ft. long by 8ft. diameter. Water for the condenser is obtained by pumping from No. 4 pit to a large concrete pond for storage. The water is sent through the condenser by means of a circulating pump supplied by Messrs. Drysdale and Co., Glasgow. An interesting part of the works is the machinery provided for cleaning coal as it comes from the pit. There are three tables for coal-cleaning, three shaking screens, and three self-acting tumblers. When a tub of coal arrives at the surface it is passed to the tumbler, and the coal falls down the screen, where after being dealt with, it passes along to a wagon. The dross drops through the screen to a conveyor, which takes it to a wagon, by means of which it is conveyed to the washer and afterwards classed in the different sizes. The Lührig Coal and Ore Dressing Appliances Limited, London, have provided the machinery for this part of the works.

Correspondence.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

PUMPING.

Sir,—I beg to submit the following in answer to the question asked by E. H. in No. 8, Vol. IV.:—

Question.—Required the best and most economical pumping plant capable of delivering a maximum quantity of 120,000 gallons of water through a height of 300 yds. in 1 hour. The above is for a permanent pumping station, and initial outlay need not be considered.

Answer.—To find the size of pumps we may proceed as follows:—120,000 gallons per hour = 2,000 gallons per minute. Say we allow 5% for leakage, and take the speed of the pump at 120 feet per minute, which is frequently obtained in many large pumping plants. Then the calculated quantity of water raised per min. will be 95 : 100 :: 2000 : 2105 gallons per minute.

$$\frac{\sqrt{2105}}{120 \times \cdot 034} = \frac{2105}{4 \cdot 08} = 515 \cdot 9 \text{ inches area.}$$

$\sqrt{515 \cdot 9} = 22 \cdot 7$, say 23 ins. diam. of pumps.

Size of cylinder:—2105 gallons raised 300 yards = $2105 \times 10 \times 300 \times 3 = 18945000$ foot lbs. per minute. Say we take the useful effect of the engine at 70 %, which is a very fair efficiency for a large pumping engine. The work done by the steam =

$$\frac{18945000 \times 100}{70} = 27{,}064{,}285 \cdot 7 \text{ ft. lbs. per min.}$$

Assume the average pressure of steam at 50lbs. (boiler pressure 80 to 90 lbs.) and the speed of the engine to be the same as the pump, then the size of cylinder will be as follows:—

$$\frac{27064285 \cdot 7 \text{ foot lbs.}}{7854 \times 50 \text{ pressure} \times 120 \text{ piston speed}}$$

$$= \frac{\sqrt{27064285 \cdot 7}}{4712 \cdot 4} = \sqrt{5743 \cdot 2} = 75 \cdot 7$$

say 76 inches diameter of cylinder.

As the question states that the above is for a permanent pumping station, I would adopt one of Davey's compound condensing differential pumping engines, placed at the surface, as it is one of the best and most economical pumping plants that could be applied to deal with such a large quantity of water. I should work two sets of pump rods, alternately raising the water, the bottom set to be a bucket lift, raising the water 70 fathoms or 140 yards, and the top set to be a plunger, delivering the water from 70 fathoms up the shaft to the surface. The two sets should (as near as possible) be made to balance one another so that the speed of the engine may be more uniform. It would be wise to have the pipes or rising main of the lower set a little larger in diameter than the bucket, say 1 inch, so that if ever the bucket door is drowned and the bucket needed repairing it could be drawn up through the rising main. The working barrel should also be ½ inch larger in diameter than the suction clack to allow it to be lifted and drawn up for the same purpose.

The diameter of the cylinder found would be the size of the low pressure cylinder, and the ratio of one cylinder to the other in compound engines are generally taken as 1·5 : 1 ∴ the size of the small or high pressure cylinder will be 1·5 : 1 :: 76 : 50 ins. diam.—THOS. HILL, Crosby Villa, by Maryport, Cumberland.

[As this question represents an actual case we handed the answers to the gentleman requiring the information, and he states the above most nearly answers his purpose. The following answers are commended:—Alex. Bailie, 47, Pitt Street, Newton, Glasgow; T. Watson, 3, East Hedley Hope. Tow Law J. McDonald, Crosby Villa, Maryport; J. Laverick, Butterknowle, R.S.O., Durham.]

BRECKON HILL,
March 20th, 1896.

To the Editor of "Mining."

Sir,—I beg to tender you my best thanks for your kindness in forwarding a testimonial for me in connection with the Indian appointment. I am pleased to inform you that I have been appointed as Manager for the Shampur Collieries, near Barakur, Bengal. Hoping I shall be able to repay you in some way, such as forwarding you some foreign mining matter. Your paper will still be one of my favourites in connection with mining.

I remain, yours faithfully,
MYLES BROWN.

[We congratulate Mr. Brown upon his appointment and will at all times be pleased to hear from him.—ED.]

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Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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The Lothian Coalfield and Recent Developments at Newbattle Collieries.*

By Mr. John Morison.

HAVING been asked, in connection with the recent visit of Members of the South Wales Institute of Engineers to Newbattle Collieries, to contribute a Paper giving some particulars of the Lothian coalfield, and the recent operations in developing the field at Newbattle, the writer has pleasure in submitting the following as supplementing the remarks made by Mr. Archibald Hood on the occasion of the visit of the Institute.

The coalfield in the neighbourhood of Edinburgh, and contained in the counties of Midlothian and Haddington, may be described as lying in two basins, the first and most important of which stretches from a point about four miles south of Newbattle down to Musselburgh, which lies about four miles north-east from the same point. The second basin lies to the south-east of Newbattle, in its upper reach, and extends in an easterly direction towards the coast by Tranent and Prestonpans.

The importance of the coalfield is chiefly due to the seams found in the lower carboniferous formation, which is almost entirely passed through in the "Lady Victoria Pit" recently sunk by the Lothian Coal Company at Newbattle. The seams of coal and other strata are heavily inclined on each side of the basin, the "dip" at the outcrop on the north-west being almost vertical, and on the south-east outcrop 1 in 1½.

*From the Proceedings of the South Wales Institute of Engineers.

The extreme depth of the lowest or "Parrot" seam, in the centre of the basin, will probably be found to be about 800 yards.

The Millstone Grit series lies above the carboniferous formation, the outcrop being exposed almost immediately to the "dip" of the Lady Victoria pit, and consisting of coarse sandstones and shales of a vertical thickness of about 200 yards. So far as the writer has been able to ascertain, the various formations in the basin are of the following vertical thickness:—

	Yards.
I. Coal Measures	496
II. Millstone Grit	200
III. Carboniferous Limestone	592
IV. Calciferous Sandstone	666
Total	1,954

No. I.—The coal measures contain a number of workable seams, of which the following are worked by the Lothian Coal Company, at their Whitehill and Polton Collieries, viz.:—

	Ft.	Ins.
The Great Seam	6	6
The Rough or Diamond Seam	4	0
The Splint Seam	2	10
The Parrot Rough, containing Oil Shale	4	0
The Jewel Seam	2	8

No. II.—The Millstone Grit contains no coal of workable thickness, but consists of alternate layers of rough sandstone, characteristic of the series, blue shale, and fireclay. There are indications that the formation is very heavily watered, owing to the porous nature of the sandstones, and it was partly in view of this consideration that the site of the Lady Victoria pit was selected clear of the series.

No. III.—The Carboniferous Limestone formation contains the following workable coal seams, viz.:

	Ft.	Ins.
The Great Seam	7	0
Diamond	2	6
Coronation	3	6
Splint	4	0
Parrot	3	3

The names of these, although in three instances the same as those in the upper series, are, it is needless to say, different seams.

No. IV.—The Calciferous Sandstone series contains several seams of bituminous shale, which is worked extensively on the western outcrop, by the Clippens Oil Company, for the extraction of petroleum by distillation. A bed of limestone, locally known as the "Burdie-house limestone," is also contained in the series, and worked. This bed is peculiar in respect that it is held by many geologists to have been deposited in fresh water, while the limestones in the carboniferous formation have been deposited in salt water. At the "Lady Victoria Pit" the strata dips at about 1 in 4, and

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it is expected that this and a gradually modified dip will extend to a distance of about 800 yards, at which point the centre of the basin will be reached and the dip reversed. The system of working the seams is entirely longwall, the Parrot seam being worked with the "levels" or gateways parallel to the "strike" of the seam, and with the levels or gateways 20 yards apart; and the other seams with main gateways 80 yards apart parallel to the "strike," with gateways, or, as they are locally termed, "fetches," directly to the rise and 14 yards apart.

The seams are heavily watered, the workings having been gradually deepened from the surface without precautionary barriers for preventing the descent of the water to the 300-yard levels.

During recent years, however, a considerable amount of water has been intercepted by a system of surface drainage.

It may be interesting to note that in several of the seams, and more particularly in the "Parrot seam," the seam yields water at any depth which has yet been reached whenever it is cut, notwithstanding that the point at which it may be cut may be thoroughly protected by whole coal to the rise up to a distance of 200 yards.

The development of the field at the "Lady Victoria pit" was decided upon owing to the cost of working the field by heavy inclines from the shallower pits to the rise, and while within the scope of this Paper it would be impossible to give in great detail the complete operations of sinking and equipping the colliery, it may be appropriate to give a general description, with allusion to some of the special features.

The shaft is 20 feet 1½ inches in diameter finished, and 550 yards deep. Sinking occupied about 3½ years. During the course of sinking water was met with in greater or less quantities in every sandstone met with in the course of sinking down to a depth of 340 yards.

It may be useful to note that in a 4-inch borehole drilled previous to sinking by means of the diamond drill to a depth of 280 yards there was no indication of water. The first water met with of any importance in sinking was at a depth of 60 yards, and amounted to 60 gallons per minute. And this was gradually increased as each sandstone was passed through, until at 340 yards the quantity of water tapped amounted to 500 gallons per minute. This was dealt with by placing in lodge rooms and in the shaft direct-acting steam pumps, which were placed at points where important bodies of water came off as the sinking proceeded. At 260 yards a feeder of water amounting to 150 gallons per minute was met with issuing from "gullets" in the sandstone, and below this a bed was formed, with a view to damming back the water with concrete walling. This was successful to the extent of about 130 gallons per minute, and was the means of greatly relieving the difficulties with water. The arrangement for this work was as follows:—After forming a "bed" for the "crib," the latter, consisting of a cast-iron water ring and crib combined, was laid and walling commenced. After forming the building on the "crib" to the finished size of the shaft, which was done with special bricks carefully laid in Portland cement mortar, two castings, consisting of a box shaped to the shaft, with a hollow space towards the back and a shut-off cock and pressure gauge tap within the front recess, and with two branch pipes cast to the upper part, and communicating with the back recess of the box, were built in, one on either side of the shaft. Pipes were attached to the branches, and were led up, four in number, to four "gullets" from which the chief feeders of water issued. Holes were formed in the "gullets" sufficient to take the pipe ends which were inserted, and the "gullets" were wedged up with wood wedges, round the pipes and above. The valves at the bottom of the pipe were left open, venting the whole of the water which they could draw from the "gullets." The walling was then commenced, and consisted of an outer ring of brickwork 10½ inches thick, backed with concrete, consisting of 1 cement, 1 sharp sand, and 3 broken bricks or hard stone carefully screened. This was put in to a thickness of about 14 inches behind the brickwork, the whole thickness being 24½ inches. This, as well as all the other brickwork, was put in with a "Galloway scaffold," to which reference will be made hereafter.

The method of building adopted was to build about 3 feet of outside brickwork, forming a complete ring round the shaft, with a recess for the concrete remaining behind. When this was sufficiently set the concrete was poured in. Various methods were tried in putting in the concrete, but the method which was finally adopted, and which appeared most satisfactory, was to send the concrete down to the scaffold in bags mixed dry, and to pour it from the bags into position. Whilst doing this, in order to prevent currents of water amongst the concrete, the ring behind the brickwork was dammed off in sections, and the concrete filled into these sections one by one in still water, the water which was running down the sides of the shaft being diverted into another section. In order also to prevent currents, where water was issuing from the rock, numerous short iron pipes were inserted, brought through the brickwork, and left open. This was continued for a total distance of 30 yards above the "crib," and about 15 yards above the

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water, after which it was left with all the pipes open for about six weeks, when all the small pipes were plugged and the cocks shut. A pressure gauge fitted to the tap, provided for the purpose, registered a pressure of 170 lbs. per square inch. The statical pressure due to the depth of the pit would be 380 lbs. per square inch.

The writer's estimate for cast-iron tubbing for the purpose was £115 per yard, which estimate was confirmed by one supplied by an experienced sinking contractor. The estimate for concrete walling was £30 per yard, which was closely approximated to in practice.

The concrete fulfilled its purpose very satisfactorily, although there was some inconvenience from small jets issuing at certain points where the work had probably been interfered with in setting by currents. The total quantity so issuing was estimated at 20 gallons per minute over the whole surface.

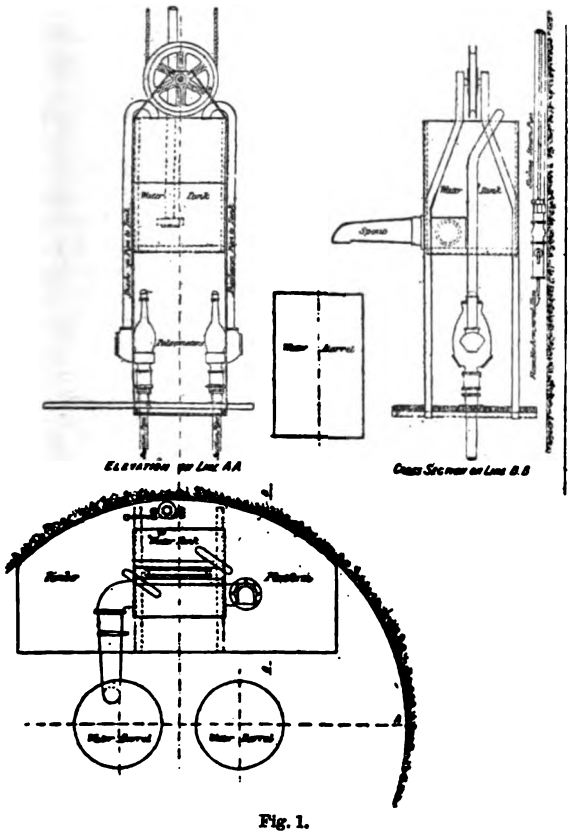

Fig. 1.

In dealing with the water in sinking, in addition to the direct-acting steam pumps referred to, an arrangement for filling the water barrels in the bottom was designed and adopted (*see* fig. 1). This consisted of a large tank, suspended on a crab rope, and attached to the bottom of the tank a scaffold of suitable size for carrying two pulsometers, the suction pipes of which descended to the working bottom. The pulsometers, which, together with all parts, were placed in duplicate, pumped alternately into the tank, which was provided with suitable valves, and leather or canvas hoses, which, upon the descent of the water barrels, were thrown into them by the attendant placed upon the pulsometer scaffold. The attendant opened the valve with a foot lever, meanwhile steadying the barrel, and the valve being of large dimensions the barrel was instantly filled. Two barrels of 600 gallons capacity each were employed. The winding engine was provided with two drums, one being clutched to permit of adjustment of the ropes. The barrels were filled at such a distance above the bottom as not to interfere with the men working, and by means of the clutch drum one water barrel could be run to the scaffold whilst the other rope worked the debris kibble. With the arrangement described, it was possible to continue sinking, and to deal with 200 gallons of water per minute in the bottom with the barrels. The pulsometers and parts were supplied in duplicate in order to avoid stoppages through the suction pipe becoming choked with sand, and for repairs, etc. A quick coupling on a sliding steam-pipe provided means for rapid detachment and adjustment when firing shots, and the rest of the apparatus, including tank, scaffold, pulsometers, and pipes, was hauled up by the crab to a safe distance when shots were fired. As already stated, the walling was done with a Galloway scaffold, which has been fully described in a paper read by the writer before the Federated Institute of Mining Engineers, and which is published in the Transactions of that body.

The whole of the shaft was walled by means of this arrangement whilst sinking progressed, the walling being done simultaneously with sinking. The winding engines used had no special feature except the "clutched drum," which was specially constructed for sinking with double ropes. The engines were 24-inch cylinders, by 5-feet stroke, 10-feet drums on first motion, and steam supplied by Lancashire boilers at 100 lbs. pressure. During the progress of the sinking the permanent pulley frames, consisting of steel box girder section, were erected, the sinking frame and pulleys being so protected that no rivets, tools, or other loose materials could fall down the shaft.

A special feature of the legs, which are 85 feet high, and fitted with 19-feet pulleys weighing 7 tons each, is the means of lifting the pulleys up and placing them in position.

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This arrangement consists of a quadrant built of steel plates, one arm of which stands vertical, and the other arm of which extends at right angles, so that it projects to the front of the legs, and overhangs the front of the pit, over one of the permanent lines of railway. At the end of each arm of the quadrant is a pulley capable of taking the crab rope, which is passed over both pulleys, and down to the truck in which the main pulley is brought forward. The pulley is then hoisted up until it reaches the horizontal arm of the quadrant, when the rope is made fast, so that the load can travel no further up. The crab being again started, the quadrant is tilted up until the horizontal arm assumes a vertical position, at which point the pulley shaft is exactly over its bearings, into which it may then be lowered.

(To be continued.)

How a Mine may be Dry but not Dusty.*

By GEORGE FOWLER, M. Inst. C.E.

THE growing conviction that many colliery explosions, if not originating in the explosion of coal-dust have at all events been greatly intensified thereby, has made the dust problem one of the most important to the mining profession and to the legislature. There can be no doubt that the next Coal Mines Regulation Bill will contain an attempt to grapple with this question in as thorough a manner as the knowledge and experience at our disposal is capable of doing. If this information be insufficient or the deductions from it erroneous it is possible that much harm may be done.

In the writer's judgment the drift of professional opinion is too much in favour of one line of treatment and of one remedy. It is with the view of suggesting other remedies that these notes are offered for the consideration of the members of this Institution.

The questions which the writer would like to place before mining engineers before they advocate and then adopt the various methods of watering dust which are before the public are:—(1) Is it possible to minimise what may be termed the production of dust? (2) Is it possible to remove it or the greater part of it by a dry method?

Let us first deal with the production of coal-dust in a modern longwall colliery. The roadways are now nearly wholly made through the rock and shales of the strata overlying the coal seam. The dust of these strata is earthy, incombustible, and not itself a cause of danger. When we reach the working-faces, we for the first time come into contact with the coal *in situ*. The ordinary work connected with the hewing and loading of the coal does undoubtedly make dust, and the very finest of this is no doubt carried more or less by the ventilation into the return airways of the mine.

The dust found on the main haulage roads of the mine is produced either by dust blown by the ventilation from the loaded wagons, by dust blown by the ventilation from empty wagons, or by coal falling from the wagons and crushed either by the feet of men or horses. It is the opinion of the writer that this is the main source of dust in coal mines. He is also of opinion that in a large number of cases the dust is thus produced in needless abundance, and that it is possible to introduce changes in the conveyance of coal to the pit bottom, which will make the dust problem one of easy solution.

With a view of ascertaining the amount of dust deposited on the roof and sides of a large colliery, the writer has made numerous measurements of the actual thickness of dust deposited in one district of the Cinder Hill colliery. It may be premised that this colliery was sunk nearly fifty years ago; that its workings are perfectly dry; that the production of coal from it during that period has reached nearly 10,000,000 tons; and that the district from which the plan is copied has been in work at least thirty years. It has not been possible to exactly measure the thickness of dust deposited on the intake airways, but the author's estimate is that on timber and sloping sides the dust from the pit bottom along the engine plane may be estimated to be $\frac{1}{2}$ inch in thickness, or would have been if it had not been removed. On the engine bank it has also at various times been removed, so that the quantity in the roadway does not now exceed a film of, say $\frac{1}{4}$ inch in thickness on the sides and roof.

In the return airways no attempt has ever been made to remove the dust, and the measurements there made represent the maximum collecting power of the roof, timbers, and sides of the airways, during the thirty years or so in which this airway has carried 40,000 or 50,000 cu. feet of air per minute.

It will be noticed that the film of dust is insignificant for 900 feet back from the face; this represents the distance worked in three years; and shows that for that length of time the collection of dust is insignificant. At a greater distance from the face, in the airway, the dust is a good deal blacker than the rest, and it represents a period of years during which the workmen worked with flaming torch lamps, which gave off a considerable quantity of smoke. This period of working is very clearly shown on the sides of the return airway.

* Extract from Paper read before the Chesterfield and Midland Counties Institution of Engineers.

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Nearer the shaft, the thickness of dust increases, and in some cases it measured 1 inch in thickness, and so far as the writer knows is the aggregate collection of thirty years of use. Allowing for portions to which dust does not adhere, and for dust lodged on timber, the writer's estimate is that this airway, which measures 10,500 from the face to the upcast shaft, contains at the present moment only 5,400 cu. feet of dust, and that this represents the undisturbed collecting power of the airway for thirty years. It is easily reckoned from this that the daily collection of dust does not exceed ½ cubic foot.

This dust is the dust from dry and dusty working faces, and is in no sense the dust arising from the conveyance of the coal to the bottom of the shaft. With reference to this branch of the subject, the writer must now premise that he considers the conditions, for reasons which he will give later, are exceedingly favourable to a slight deposition of dust. He is under the impression that the maximum thickness of dust, if it had never been disturbed, upon roof timber and upon convenient ledges on the level engine plane, would not exceed 1 inch at the present moment, although this road has been in operation for forty years. He considers that on the engine bank to the working-faces, at the upper end ¾ inch, halfway down ½ inch, and 1,500 feet from the working-faces a mere film is all that would have collected had no dust ever been removed.

The writer must here call attention that he is speaking only of the roof and sides, and that he will deal with the floor in another way. Confining his atttention to these points the writer's opinion is that the outside estimate for the possible collection of dust on the roof and sides would have been for the first 3,600 feet, a maximum of 10,800 cubic feet, over a period of forty years, or a daily collection of not exceeding 1 cubic foot.

It now becomes of interest to investigate why this quantity of dust is so small. And in the first place, as already referred to, there can be no doubt that the roads being primarily made in the rock roof yield little or no carbonaceous dust themselves, and that for hundreds of feet back from the working-faces the only dust is a grey dust, the colour of Portland cement.

The dust, therefore, that is made in these roads comes entirely from the dust caused by the haulage of coal; and here the writer would point out why the conditions are so favourable for the non-production of dust. In the first place, the pit waggons at this colliery are close-ended wooden wagons; secondly, they are emptied at the pit top by being turned over in revolving tipplers; in the third place, the haulage is entirely done by machinery.

There are no horses to trample up and crush any coal which may fall off the wagons. So far as can be ascertained, it appears that the coal which does fall off does not not exceed ¾ per cent. per day of the coal drawn, and this coal is nearly all picked up in lumps and sent to bank. It is only in turn-outs or bank-heads that any crushing to dust can very readily take place. The little dust that is produced comes mainly from that which the ventilation blows from the loaded wagons. For as already pointed out, the empty wagons are completely tipped over and emptied of dust at the pit top.

The first practical inference, therefore, which the writer would like to draw is that all forms of open-ended wagons, or lattice-framed wagons, are highly objectionable.

Having briefly dealt with the accumulation of dust in a large and old colliery, where the conditions for the conveyance of coal from the working faces to the pit bottom are highly favourable for the prevention of waste by the way—which the writer believes to be the main cause of the dangerously dusty mine, and which he believes is the reason why this mine in question is so remarkably free from dust—the writer now desires to call the attention of the members of the Institution to the conditions which are most favourable to the prevention of the deposition of dust on the roof and sides of a mine; and to its easy removal.

He has already shown that the quantity of dust, even when an accumulation of years is probable, is small: and the question he would like to lay before the members of the Institution is, is it not possible (instead of schemes of water pipes and water jets, which are very costly to install, which are very costly to use, and which he will later on point out are very objectionable to use) in the first place so to construct the roadways that the accumulation of dust may be still less than in this case described he has shown it to be?

With a view to testing this point, he has specially prepared two portions of a roadway of this colliery of a total length of 1,500 feet, so that the sides and roof are smooth and easily swept. Where the roof is timbered, and the roadsides are packed, these packs have been plastered with mortar, until the surfaces are smooth and not dust-collecting, and the cost of this operation is found to be 1½d. per square foot. When the binds are strong, they have been slightly trimmed with the pick at a cost of 1d. per foot.

It will be understood that a thin coal seam runs along some part of the roadway. This has been trimmed in a similar manner, and at about the same cost. On the upper edge of this thin coal

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band are 5 or 6 inches of very weak binds, which are apt to shell off, and leave a little shelf of dust collecting capacity. This little shelf has been plastered up like the packs, and ceases to perform that function. Below the thin coal seam are the original bind packs of the working face. These have been squared up and plastered smooth, or underbuilt with stone, and the whole sides of the roadway, measuring 1,500 feet in length, have been made smooth at a cost of 10d. per lineal foot.

No doubt these costs will vary somewhat in different places, but, in the mine in question, the trial portion of 1,500 feet cost altogether £75, and he is of opinion that the whole 4 miles of roadway might be made smooth at sides and top for a total cost of little over £1,500; and that if it was desirable to still further illustrate the presence of small portions of dust, and to bring the roadways of a mine into what might be called a high state of dry polish, the roadways might be white-washed through from end to end at a total cost of £500.

When we have before us the figures of the enormous cost which the advocates of the wet method will incur in the first instance, in pipes and jets to saturate the air of the mine, these costs, though large, are small by comparison.

It will be observed that up to the present, the writer has made no reference to the practical dealing with the floors of the roadways; and in this matter he is prepared to be a partial advocate of the aquatic treatment. He would, however, desire to say that in turn-outs, bank heads, pit bottoms, and places where the wagons bump against each other, there is much to be said for brick pitching, which costs rather less than 1½d. per square foot. Further, these places should be frequently swept, and dust and rubbish cleaned up and sent to bank or stowed away. Subject to these, and more or less general cleaning away, he is of opinion that water tanks, with distributing pipes under the middle of the tank, may be advantageously drawn about by ponies, or moved by the haulage ropes, and that the main roads of a mine should have a smooth and moist surface maintained by these simple and inexpensive means.

The writer now desires to make some practical comments on the wet method of dealing with the dust of roadways, but the greatest of many objections to the aquatic treatment are, first, that in the majority of cases in this country the roofs and sides of mines will not bear to be kept constantly wetted if they are to be kept sound and upstanding. The second great objection is that a water-spray system, if it be not continuously maintained, is itself a great producer of dust. If coal itself or the shales and rocks above coal are alternately wet and dry, a most powerful pulverizing agency has been brought into operation. A third great objection to the spray system lies in the injury which it is certain to cause to the health of the miner. In the writer's opinion, more men would die from water-sprays than now die from dust, and in this way only the remedy would be worse than the disease. In conclusion, therefore, the writer submits that from every point of view, lessened original cost and greater efficiency, the dry method is capable of removing the unavoidable dust of coal mines.

Awards.

In lieu of the one Prize of 10s. 6d. which we first proposed giving, we have awarded two Prizes of 7s. 6d. each for the descriptions of Harris Deep Navigation Colliery, by Giles Jones, No. 9, Pleasant View, Treharris, South Wales, and Ireland Colliery, by R.W.C. The illustrations given represent R.W.C.'s original sketches. (Will this competitor please send his name and address.)

Several other good descriptions were received, and we will doubtless publish some of these in future issues.

The following are commended:—J. J. P., J. C. Binks, Sandhill, Rawmarsh, Rotherham; Alex. Baillie, 47, Pitt Street, Newton, Glasgow; J. E. Keefe, Amble, Northumberland; G. W. Hedley, Medomsley Edge, Medomsley, R.S.O., Co. Durham.

Description of Hallside and Newton Collieries (no name).

Notice to Competitors.

Some competitors cause us considerable annoyance and trouble through carelessness or, in some cases, perhaps ignorance, and thereby decrease the possibility of gaining an award. We therefore advise competitors to digest the following hints and profit therefrom. Write legibly and on decent sized paper. When there are several sheets fasten them together, and write your name and address on one or more of the sheets and not on a loose slip. Make sketches on *unruled* paper in good black ink. There is no objection to sketches being drawn larger than the intended reproduction, in fact it is better to so make them. Make the sketches clear even if you cannot make them neat enough for reproduction. When posting leave the ends of the package open or the flap of the envelope unfastened, and stamp at book rates; but if you will persist in sealing up the papers, at least have the goodness to pay the full postage. All competition letters should be addressed to Editor, "Mining," *Clarence Works*, Wigan, not to the Publishers at London.

Any information respecting Advertisements in this paper will be given on application to the "THE MANAGER," Advertisement Department, "Mining" Office, *Clarence Works*, Wigan.

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EXAMINATION QUESTIONS,

WITH ANSWERS BY

J. CARTER, First-Class Certificated Manager.

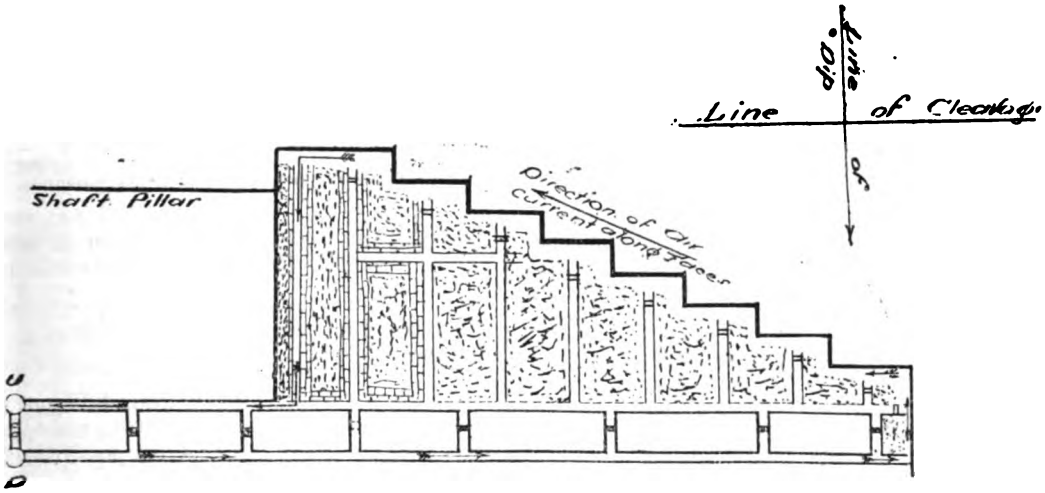
Questions given in the South-Western District, Sept., 1894, for Under-Managers' Certificates of Competency.

(The figures in parenthesis show the number of marks obtainable.)

No. 3 Subject—PRACTICAL MINING.—Contd.

(120 marks to qualify.)

Q. 3.—Sketch a plan showing how you would open out a piece of longwall work in maiden ground, marking the direction of dip and slips, and show by arrows how you would ventilate the workings. (20)



ANS.—The sketch I have shown has the working face on the step principle, and is a suitable method for mines of a moderate dip. Only the workings of one side of the shaft are shown, but I would have a similar district on the opposite side. The ventilation of course at present is one continuous current across the faces, but when the mine became more opened out then I would divide it into districts and supply each district with fresh air.

Q. 4.—If three workable seams of coal occur in water bearing strata at equal distances apart, and within a depth of 20 yards, in what order would you work the seams, assuming the roofs to be similar in character? State your reasons. (20)

ANS.—I should work the seams in the following order:—The top seam in advance of the 2nd, and the 2nd in advance of the 3rd. By working the lower seams first the coal is harder and roof more difficult to deal with, and roadways more expensive to keep in order, consequently a greater cost per ton to get in the upper seams. In addition to the above I should be able to collect the water in the upper seam and the overlying strata, which would greatly relieve the lower mines from a good portion of the water.

Q. 5.—In working a seam of coal from the outcrop to the dip, what precautions would you take as a security against being troubled with water? (20)

ANS.—I should work such a seam in the pillar and stall method, taking care near the outcrop to leave sufficient pillars in as a support for this surface land, and especially should any surface water be lodging near the outcrop.

Q. 6.—If in examining a district during the working hours of a shift you find a dangerous accumulation of gas, what course would you adopt? (20)

ANS.—In accordance with G. Rule 7, C.M.R.A., I should immediately withdraw all the workmen in the district so found dangerous. After the withdrawal of all the men in this dangerous district I should fence it off and make a true report of such, and under such conditions a person shall, except in so far as is necessary for exploration, or removal of same be readmitted in such part so found dangerous, until the same has been reported by the person appointed for the purpose not to be dangerous. Every such report shall be recorded in a book which shall be kept at the mine for the purpose, and shall be signed by the person making the same.

Q. 7.—What are the requirements of the Coal Mines Regulation Act, 1887, with regard to the employment of youths under 16 years of age? (20)

ANS.—The employment of boys under 16 years of age below ground is limited to 54 hours per week, and to not more than 10 hours in any one day. Also an interval of 12 hours rest is to be allowed between each consecutive period of employment, except between Friday and Saturday, when an interval of 8 hours will suffice. The time begins when they leave the surface and ends on reaching same. Boys under the age of 12 must not be employed at all.

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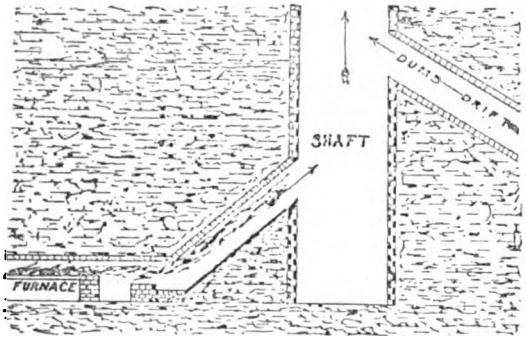
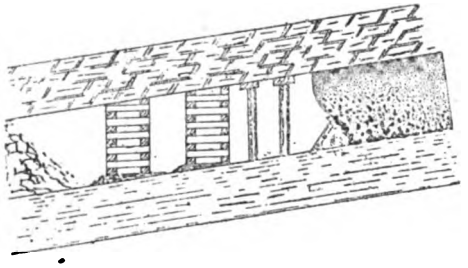
Q. 8.—What is a dumb drift? Give sketch. (20)



ANS.—A dumb drift is a roadway cut in the rock from the return and driven at such a rise as to come out in the shaft at a height sufficient to carry the return air away from any flame that may be given off from furnace or underground boiler fires. Therefore we may say that a dumb drift is a roadway used exclusively for the purpose of carrying the return air of a mine out of the reach of any flame likely to be produced from furnace or boiler fires.

Q. 9.—Make a sketch to show the proper positions in which props should be set, and "chocks" or "cogs" should be built in working a seam in stoop measures. (20)



ANS.—I have shown a sketch here of a mine with a dip of from 1 in 3 to 3½.

Q. 10.—The percentages of accidents from falls of roofs vary considerably in different collieries, even when the seams of coal worked the character of roof and the mode of working are similar. How do you account for the variations? (20)

ANS.—The variation may be due to the difference in dip, as it is generally found that more accidents occur from falls in steep mines, or to the difference in management; one colliery manager may enforce definite and adequate timbering, while another allows the workmen to do just as they like, and needless to say there will be more accidents from falls in the latter case.

(*Concluded.*)

Chesterfield and Midland Counties Institution of Engineers.

At a meeting of the above, held at Derby on the 4th inst., Mr. George Lewis presiding, Mr. George Fowler contributed a paper on "How a mine may be dry but not dusty," which, in the absence of the writer, was read by the Secretary; an interesting discussion followed. A paper by Mr. W. S. Gresley on "The Yorkshire and Nottinghamshire Coalfield—Geological suggestions relating to its Eastern Extension," and Professor Hull's paper on the Eastern limits of the Midland Coalfield were considered together.

Competition Questions.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before May 1st, 1896.

We invite readers to forward questions for this competition.

(1) Sketch a longwall district for 30 hewers in a shaft. Indicate the course of the ventilation.

(2) What treatment do you consider most practicable for minimising the risk of a coal dust explosion?

(3) In dividing a mine into different splits of ventilating current, what are the chief points to take into consideration? Give possible example.

Ireland Colliery, Staveley, near Chesterfield.

(COMMUNICATED.)

DESCRIPTION.—The Ireland Colliery is situated about 5 miles to the north-east of the town of Chesterfield, in the carboniferous limestone series, and is on the Midland and the Manchester, Sheffield, and Lincolnshire Railways. The minerals are on the Duke of Devonshire's estate, and the pit is also sunk on the same estate. Only one large fault has been proved, which is known as the Inkersall Fault, and which runs about parallel to the rise. Coal is raised from this shaft, which is the downcast to the colliery, while another pit, bearing the name of Hartington Pit, is the upcast. The number of workmen employed at this colliery is about 660, and the quantity of coal raised is about 1,100 tons per day.

The following are the sections of the coal seams taken in the Ireland shaft, their thickness and their depths from the surface. See fig. 1:—

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Fig. 1.

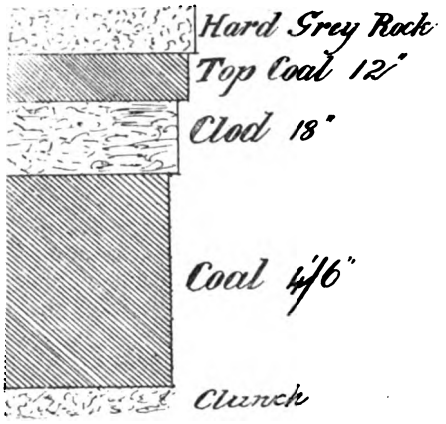
Seams.	Thickness. ft.	in.	Depth. yd.	ft.	in.
Coal	2	8	16	1	1
Coal	1	0	54	2	4
Coal	2	0	65	2	3
Yard Coal, soft & good.	2	10	75	2	6
Coal	0	1	104	0	8
Coal	0	3	131	2	2
Top Hard Coal	2	8	141	2	9
Coal	0	2	148	0	2
Coal	0	2	158	2	8
Coal	1	7	183	0	11
Coal	1	11	184	0	5
Coal	0	6	184	1	5
Coal	0	3	184	1	10
Coal	0	6	184	2	8
Coal	0	3	185	0	0
Inferior Coal	0	5	185	1	1
Cannel Coal, very good.	1	7	198	1	4
Coal (Very good coals)	0	6	208	1	3
Blackshale (Very good coals)	0	4	208	1	7
Coal (Very good coals)	1	8	209	0	3
Blackshale (Very good coals)	2	10	210	0	1
Coal (Very good coals)	1	4	210	1	5
Coal	0	11	213	1	10
Coal	0	3	220	2	6
Coal	0	5	231	2	4
Coal	0	11	242	2	4
Coal	0	6	251	1	8
Coal	0	7	277	2	2
Coal	1	10	273	0	2
Coal	0	7	282	1	2
Coal	1	7	287	0	11
Coal	1	6	288	1	2
Coal	0	5	343	1	8
Coal	2	0	351	0	6
Coal	0	8	353	0	10
Coal	1	3	362	0	4
Deep Soft Coal	4	7	364	0	3

SECTIONS OF THE COAL SEAMS.

Scale—55 yards to an inch nearly.

There is only one seam worked by the Company (The Staveley Coal and Iron Company, Limited), and that is the Deep Soft Coal Seam. This coal is well known as an excellent gas-coal and household coal, and commands a very good price in the market. (See fig. 2 for section.)

Fig. 2.



SECTION OF DEEP SOFT COAL.

SHAFTS.—This seam is only worked from one shaft, namely, the Ireland Shaft. The pit is 364 yards in depth and 15 feet in diameter, and is situated very near to two railways, the Midland and the Manchester, Sheffield, and Lincolnshire, so that there is no difficulty in getting the coal away from the pit. There are two locomotives, built by Markham & Co., of Chesterfield, which draw the full wagons on to the lines next to the main lines on both railways.

WINDING & HAULING ENGINES.—The engines used for winding at the Ireland Pit are vertical coupled, with 36 inch cylinders and 6 feet stroke. The drum is conical, tapering from 19 to 22 feet. Four tubs are drawn at a time with a double-decked cage, two tubs on each deck, and the total weight of coal and tubs averages about 3 tons. The size of the winding rope is 1¼ inches diameter and is made of the best plough steel. The engine for driving the endless rope is a single engine, double-acting, 21 inches cylinder, with a 4 feet stroke.

BOILERS.—At the Ireland Pit there are 14 Lancashire boilers, 12 of which are 30 feet by 7 feet, and the remainder 30 feet by 8 feet, all working at 60 lbs. pressure per square inch. These boilers supply steam to all the machinery at the Ireland Colliery and also to the brick-making machines and other engines in connection with the brickworks.

HAULAGE & SYSTEMS.—On the road A (fig. 3) endless rope haulage is adopted. The tubs are sent in twos and are placed on the rope at intervals of about 20 yards, B C D E F G (fig. 3) are self-acting inclines or jinneys. The empty tubs are knocked off at the bottom of each incline or jinney whilst the rope is in motion. All the coals are brought down the inclines on to a road next to the plane and are then drawn in twos on to the

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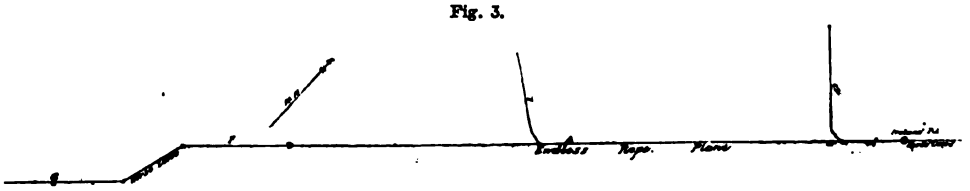
Fig. 3.



PLAN OF MAIN ROADS.
Scale—22 chains to an inch.

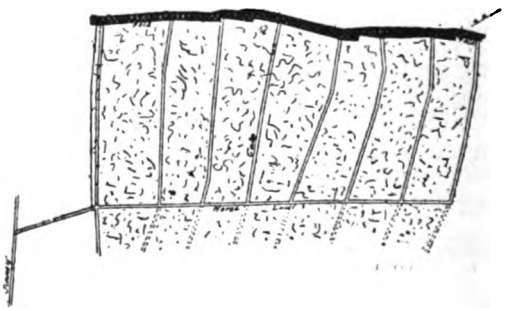
plane rope and sent to the pit bottom. Boys are employed at the bottom of each incline to knock the empty tubs off and put the full tubs on to the plane rope.

PUMPING.—As this colliery is a very dry one there are no pumping arrangements, except one small hand-pump to pump the water out of the sump. This pump is of course at the pit bottom. The water pumped out of the sump is used for watering the main roads.

VENTILATION.—The ventilator is a Guibal fan, 40 feet in diameter and 11 feet wide. The driving engine has a horizontal cylinder 30 inches in diameter with a 30 inches stroke. The speed of the fan is about 44 revolutions per minute, and the average quantity of fresh air per minute is about 92,000 cubic feet (11 splits). Steam is supplied to the fan engine by the boilers already mentioned.

SYSTEMS OF WORKING.—The dip of the seam is to the north-east, the inclination being about 1 in 20. Fig. 4 shows the method of working this seam, which is by longwall, with the roads advancing to the rise. Jinneys or self-acting inclines are set off from the endless rope plane, and levels from the jinneys cut off the roads going to the rise every 120 yards. The distance between the stalls is about 45 yards. At each gatehead iron plates and rails for the tubs are placed along the face. The tubs are lockered or spragged when being taken down the road leading to the incline. Horses pull two tubs at a time up the gateways and two full ones down the gateways with lockers in them until they get on to the levels, and then they are taken out. In a 40 yards stall two stallmen work, and they employ other men who do the ripping and packing and receive so much a yard for it, and they also receive a tonnage price on the coal sent from the stall. The ripping in the gates yields material for building the packs at the sides of the gates, which are about 10 feet wide. These packs are made 12 feet wide, and others parallel to them are built in the waste of the material yielded in the holing. The face is protected by two rows of metal props carried along the face behind the rails, 5 feet apart. As the packs are built, the back row of props is taken down and reset in advance of the other row. As the props are drawn the roof in the waste falls, and thus relieves the weight at the face. The stallmen have to build the packs and set the props as directed by the deputy. Commencing at the gatehead they hole along both sides of the gate to the extremity of their stall, they also hole 6 feet in above the coal, the height in front of the holing being 18 inches. Sprags are put in above the coal 6 feet apart as the holing proceeds. When the holing along the coal is completed a cut is made in at the gatehead, after which one or two sprags are taken out and then the coal is blown up by an electric exploder, the explosive used being roburite; it is also used in ripping the gates. As the coal is removed in the tubs other sprags are taken out and more coal taken down. This process is continued along the stall on both sides of the gate until the extremity of the stall is reached, the rails being laid forward as the coal is taken

Fig. 4.



METHOD OF WORKING.
Scale—9 chains to an inch.

down in front. After the holer has worked to the end of the bank he returns to the gatehead and begins another holing at the point from which the coal has just been removed. The stallmen employ two fillers and one holer, so that five men work in a 40 yards stall, from which they send out daily about 20 to 25 tons in 9½ hours. Timber is used in the levels but not in the main roads as the roof is very good. The boys who fetch the full tubs from the stalls and take the empty ones in are called putters, and are paid by the score of tubs they fetch from the stalls. Fig. 4 shows a district of eight stalls in operation. The onsetters at the pit bottom are paid so much for every 100 tons of

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coal sent out per day, and if the pit is not working they receive a daily wage. Marsaut safety lamps are used throughout the mine, and an electric lighting plant is now being put down both on the surface and underground.

SCREENS.—There are about 14 screens at this colliery, 15 feet long on the bars, with ¾ in. spaces or meshes, and also 2 feet of bars, flat at bottom with 1 inch spaces. These screens are used for screening the dirt from the coal, so that there may be no complaints made by the purchasers. Boys are employed for screening.

THE LÜHRIG WASHING MACHINE.—The slack from the screens is carried by a long conveyor or belt and is delivered into a large hopper in the ground, out of which it is lifted by means of two sets of elevators to the top of a large building constructed for treating the coal under the Lührig system of sorting, sizing, and washing. The elevators deliver the slack into a shoot, which carries it into the end of a revolving riddle or screen composed of three rings of perforated plates, each having different sized holes in them, which causes the coal to be sized into "first nuts," "second nuts," "pea nuts," and small or coking slack. From the revolving riddle the different sizes of coal are carried along in channels to their respective washing boxes, where the dirt or bind is taken out of the nuts by gravitation, the water being kept in motion by means of plungers working in boxes and lifted by means of eccentrics driven off the main shaft. From the boxes the three sizes of nuts are delivered on to shaking screens, which have perforated plates, so that the small pieces may be sifted from among the size larger and that the nuts may be as uniform as possible. The small coal, or what we may call dust, is also washed in a range of boxes to itself and delivered into a large hopper, where it is again elevated into some large wood hoppers and allowed to drain before being used for the coke ovens. The dirt or dross is also passed through a pair of crushers and undergoes a second washing process after leaving the first set of boxes, and the residue is then delivered into the dirt hopper and taken away to the dirt tip in tubs. The water for washing is pumped up to the top of the building or machine by means of a large centrifugal pump, and as much as possible is carried back into the pump tank or well so that it may be used many times, thus saving the water. The machine is a double one, and is supposed to be equal to washing 1,000 tons of coal in 10 hours. It is driven by a pair of engines, 20 inches cylinders and 3 feet 6 inches stroke, at 50 revolutions per minute.

WORKSHOPS.–Provision is made for repairing all the machinery and tubs at the colliery. The fitting shop contains the requisite machinery and stool for the necessary repairs and fitting-up.

There is a powder store about 100 yards from the colliery, where they give the roburite to the men, and also a lamp cabin, which contains from 600 to 620 Marsaut safety lamps. These lamps are given to the men from 5-30 a.m. to 6-30 a.m. Three men are employed in this lamp cabin, two in the day and one in the night.

Winding Ropes.*

By H. F. BULMAN.

IN his instructive paper on ropes, Mr. Westgarth mentions that it would be undoubtedly interesting "if some of the members would supply, say, the horizontal and vertical angles at which winding ropes are working at various pits, giving the size of rope, nett working load, daily output, and the lifetime of the ropes, giving the size of drum and pulleys also."

In response to this suggestion, the writer begs to give particulars of one instance as follows, hoping that other members may do likewise:—

The shaft is 483 feet deep; the cage has two decks, holding one tub on each deck; the tub weighs 5 cwts. when empty, and holds 8½ cwts. of coals. The weight of the loaded cage is 2 tons 5¾ cwts.

The ropes are 3⅛ inches in circumference, of patent improved steel wire, weighing about 11 lbs. per fathom. The weight of vertical rope hanging from the pulley at the lift of the loaded cage is 8¾ cwts., which makes the total weight to be lifted 2 tons 14½ cwts. According to Mr. Westgarth's figures, the breaking strain of this rope should be about 28 tons. The working load is therefore nearly one-tenth of the breaking strain.

The pulleys are 11 feet in diameter, and the drum 17 feet. The winding engine is an old-fashioned one, with vertical cylinder 38 inches diameter and 6 feet stroke. The centre of the pulleys is 25 feet 6 inches in vertical height above the centre of the drum, and the horizontal distance between the drum and the pulleys is 63 feet. The vertical angle of the high rope (that is the rope coming off the top of the drum) is 76°, and of the low rope 62°. The distance between the pulleys is 4 feet 6 inches, and the width of drum 5 feet 6 inches, and the maximum horizontal angle between the rope and the centre line of the pulley is only 41 minutes.

* From the Journal of the British Society of Mining Students.

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The average duration of each "wind" (cages running in the shaft) is 28 seconds, and the number of "winds" (drawing coals) during the shift of 10 hours is about 600, giving an output of 500 tons.

The ropes are in use for winding two years on an average, and cost ¼d. per score (=20 tubs=8¼ tons) drawn, the exact figures for the last three steel ropes being—duration 102 weeks, and cost 0·243d. per score, or 5s. 2½d. per week. It is a fact of some interest that over a period of 15 years, the record has been made by an iron rope, 4 inches in circumference, which was on for 346 weeks, more than 6⅔ years, and was then taken off, not because any clear signs of deterioration were visible, but because its length of life was becoming so abnormal. It cost 0·064d. per score drawn, or 1s. 2¾d. per week. Iron ropes, 4 inches in circumference, were used some years ago, before steel came into vogue. The cost and duration of the two (disregarding the phenomenon above mentioned) are very similar, but the steel ropes have the advantage of being considerably lighter.

In a report made some years ago to the French Government by M. Aquillon, 40° is mentioned as the smallest vertical angle which should be allowed, whilst some put it as high as 60°.

According to the same report, the size of drum and pulleys should be considered in relation to the size of the wires composing the rope, rather than to the size of the rope itself. The smallest diameter should be at least 2,000 times that of the steel wire, or in relation to the size of the rope, it should be not less than 80 to 100 times the diameter of the rope. The size of the wires should vary according to the size of the drum and pulleys, to the distance between them, and to the vertical angle, hence the advantage of letting a rope manufacturer know all the conditions under which a rope is required to work.

A rope made of six strands of nineteen wires each is stronger and will work better than one of equal size made of six strands of seven or eight wires each.

In Belgium, where aloes ropes are commonly used, it is customary for the rope manufacturer to guarantee them for a period of 1½ to 2½ years, or for a given output, and to allow a deduction of $\frac{1}{1\frac{1}{2}}$th to $\frac{1}{2\frac{1}{4}}$th of their value for each month short of the agreed period.

As we go to press we learn of the disastrous explosion at the Brancepeth pit, Willington, Durham, which occurred on Monday night. Very few particulars are yet to hand, but it is stated that over 20 men were in the district in which the explosion occurred, though some have been got out alive. By the time our readers see this notice, however, the full details will be probably known.

Correspondence.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

THEORETICAL MECHANICS.

Sir,—Will you or any of your readers please answer the following question:—A pair of engines, cylinders 16 inches diameter, 2 feet 8 inches stroke, coupled on the second motion at 5 to 1, spur-wheel 24 teeth, large wheel 52 teeth, drum 6 feet, steam 40 lbs. What weight will such an engine lift at start? An answer will very much oblige. J. S.

EXAMINATION OF WINDING ROPES.

Sir,—You would greatly oblige by inserting the following question in your correspondence columns to be answered by some of your readers:—What is the method adopted to examine the rope of a winding engine and the rope of a slant, and how would you know whether it required changing or not. STUDENT.

BRANDON COLLIERY, CO. DURHAM.

To the Editor of "Mining."

Sir,—I wish to inform you that I have had a lot of trouble in obtaining your paper from my newsagent for some time. I either get a paper several issues old, or when the right one, which is only seldom, almost a week old. This as you know will not allow time enough for me to enter your competition, which I should like to enter. I do not think for a moment it is any fault of yours, and if you publish this letter you will perhaps hear of the same thing from other of your readers. Yours truly, H. DAVIES.

[In respect to the above letter we may say that it certainly is no fault of ours, and as numerous other readers may experience the same difficulty we should be pleased if any who are so situated would communicate with us without delay, giving their agent's name and address and how long the irregularity has occurred. By co-operating with us we have no doubt that we shall be able to overcome the difficulty in a short time.—ED.]

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 12. Vol. IV. May 2nd, 1896.

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Editorial Notes.

THE C.M.R.A. (1887) AMENDMENT BILL.—This Bill was introduced to the House of Commons by the Home Secretary, on April 20th, and was read a first time. Sir M. W. Ridley in moving for leave to bring in the Bill said that he might fairly describe it as a non-contentious measure. It was based upon the provisions of the Bill of last year, and the Government had had the advantage of hearing the criticisms of both employers and workmen upon that measure. The Bill contained only eight clauses. Its main object was to provide for increased safety in fiery and dusty mines, and it gave power to the Secretary of State to impose special regulations with regard to various points which he then enumerated. It also made provisions with reference to complaints of masters and workmen in regard to the checkweighing clause of the principal Act. He could only say that it was most desirable, in the interests of both employers and workmen, that the law upon this subject should be made clear.

* * *

THE MANCHESTER GEOLOGICAL SOCIETY.—At a meeting of this society, held on the 14th ult., Mr. R. Winstanley, C.E., the president, in the chair, Mr. Hy. Hall, H.M.I.M., exhibited a couple of self-igniting safety lamps such as are now being used in German mines. One of these was the Wolf lamp, a German patent, and the other an ordinary Clanny, both fitted with self-igniting apparatus, one of the lamps burning benzine and the other colza oil. The igniting arrangement consists of a narrow tape carrying on its surface at intervals small patches of fulminating material, this tape being fitted inside the lamp, in connection with a small shaft passing through the bottom of the lamp. By its use a lamp could be relighted any number of times by the collier himself in the workings without danger.

Mr. Joseph Dickinson, F.G.S., read an interesting paper on "River Valleys," and this was followed by a paper communicated by Mons. X. Stainer, Doctor in Natural Science, on "The Pebbles formed in the Belgium Coalseams."

* * *

THE SOUTH WALES INSTITUTE OF ENGINEERS.—The 38th annual meeting of this institute was held at Cardiff, on the 20th ult., when Mr. H. W. Martin, M.I.C.E., Dowlais, was elected president for the next two years. Mr. Thomas Arnold made some further observations on the western part of the South Wales coalfield. Mr. James Barrow's paper on "An Hydraulic Pumping Plant" was further discussed, and Professor Elliot's paper on "The Crushing Strength of Certain Building Stones and Bricks" was considered.

* * *

COAL IN KENT.—The Kent Coalfields' Syndicate, which was formed in March, with a capital of £200,000, the whole of which has been fully subscribed, have entered into a contract for the making of two 20 feet diameter shafts at Hongham, two miles west of Dover. The two shafts are to be sunk to the 2 feet 6 inch seam some 1,138 feet deep, and have to be completed in eighteen months. They are to be equipped in the most approved manner, and capable of dealing with 2,500 tons per day. It has been estimated that there is sufficient coal in the measures already discovered, taking an area of not more than 6,000 acres to supply 3,000 tons per day for seventy years. The coal bearing district in Kent is calculated to be about 150 miles in length by 5 or 6 miles in breadth.

* * *

BRITISH SOCIETY OF MINING STUDENTS.—The Journal of this Society recently received contains the following papers:—"Notes on the Prevention of a Gob Fire in the Stockings Seam at ——— Colliery" (illustrated), by Geo. J. Binns and J. Denton; "A Method of Renewing Defective Tubbing Plates" (Illustrated), by G. Carrington Fowler; "The Lubrication of Colliery Engines," by G. E. J. McMurtrie; "Winding Ropes," by H. F. Bulman. Two of these papers will be found in the present number of *Mining*, and the paper on Winding Ropes appeared in our last issue.

* * *

SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE INSTITUTE OF MINING ENGINEERS.—A meeting of this institute was held at Mason College, Birmingham, on the 16th inst.. Mr. J. E. Cooksey, presiding. The Secretary (Mr. A. Smith) read a letter from the Staffordshire County Council stating that the Technical Committee of that body had decided to offer two mining scholarships, each of the value of £30, to which would be added, at the discretion of the committee, a maintenance allowance. Mr. R. S. Williamson (Cannock and Rugeley Colliery Company) read a paper on "Underground Haulage," in which he alluded to the importance of efficient and economic haulage. He described, by a series of plans illustrating the motor plant and the hauling system employed throughout the Cannock Wood pits, the Wimberley mine and the Pool pits, where he said the whole of the coal got had to be drawn by rope haulage to the bottom of the shaft. The amount was equal to about 3,000 tons in the eight hours. The average speed was about eight miles an hour, as he believed in moderate speed and large loads rather than small loads and quick running. The average cost of labour on the "main and tail" roads was ·60d. per ton, and in some instances it was as low as ·45d. On the endless-rope system the cost worked out at ·66d. per ton on the quantity at present dealt with, though the output could be considerably increased at no increased cost. Mr. Williamson was awarded a hearty vote of thanks for his paper.

* * *

THE MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.—A meeting of the members of this institute was held on April 18th, at Sheffield, Mr. John Nevin, presiding. Prof. Shea, of Firth College, made some remarks upon "The Roth Method of Firing Shots," which was the subject of a paper read by Mr. G. Blake Walker, at a meeting of the institute in August last. The Professor also conducted a series of experiments demonstrating the action of the different bodies which took part in igniting the detonator in the Roth cartridge. The discussion on Professor Lewes' paper on "Mining Explosives" was resumed, and the discussion on Mr. Rankin Kennedy's paper on "Electrical Machinery for Mines" was further adjourned.

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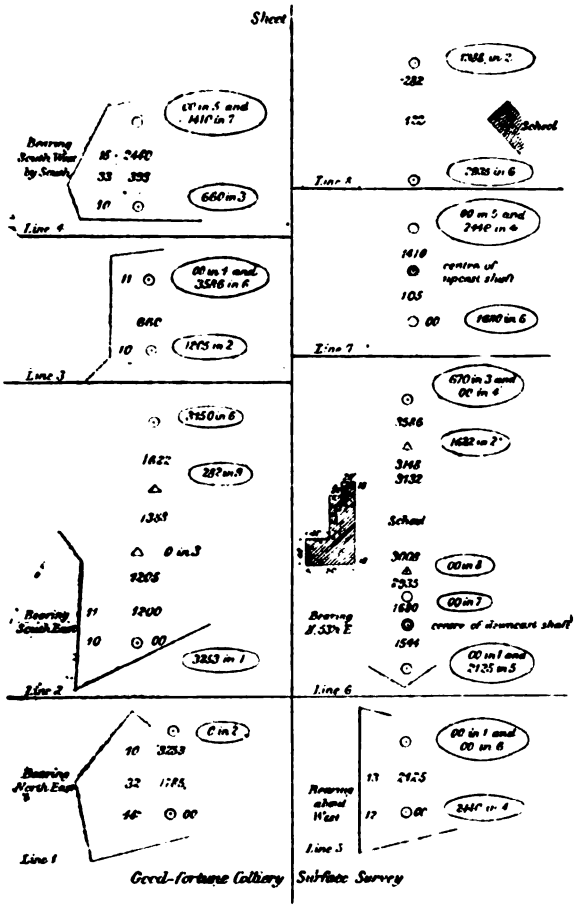
Notes on Survey Plotting.

By J. N. WARDELL.

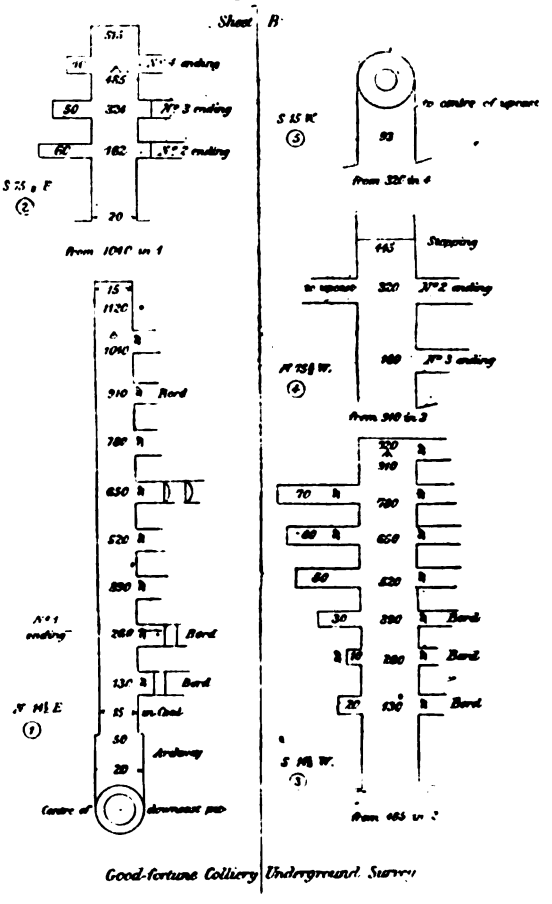
SHEET *A* is to represent the notes taken during a survey, and from these notes we are expected to construct a correct plan of the country that has been surveyed. To do this is no easy task, unless the student has been well informed previous to presenting himself for examination, for these sheets are from the examination papers of the City and Guilds of London Institute, 1894, as many readers of this journal will know.

To plot this surface survey no bearings are considered until after the survey has been plotted, and then only to connect the underground survey to the surface survey are the bearings of importance.*

On looking carefully over sheet *A*,† we find line 4 commences where line 6 ends, line 5 commences where line 4 ends, and line 6 commences where line 5 ends, thus forming a triangle, which must be plotted first. This is done by drawing the longest line (line 6) and with a pair of compasses opened to the length of line 5 (2125 links) and with the point on the commencement of line 6 describe an arc so that it will be intersected by an arc described from the other end of line 6 as a centre, and a radius equal to the length of line 4 (2440 links), then a line drawn from each end of line 6 to the point of intersection of the two arcs forms the first triangle. For the next triangle we find line 1 commences at 00 in 6 and ends at 00 in 2, and line 2 commences at 3253 in 1 and ends at 3148 in 6, thus forming another triangle which is plotted similarly to the first one. Then we come to line 3, and we find it commences at 1205 in 2 and ends at 00 in 4 and 3586 in 6, this line being easily drawn; then we go on to line 7, which starts at 1680 in 6 and ends at 2440 in 4 and 00 in 5, so that if the first triangle was drawn accurate, a line drawn from a point 1680 links from the commencement of line 6 to the point of intersection of the first two arcs will be 1410 links in length. This is line 7, and it acts as a check as well as passing over the centre of the upcast shaft at 105



Sheet A.



Sheet B.

† The following errors occur in Sheet *A*:—In line 2 for (282 in 9) read (282 in 8), and for (3150 in 6) read (3148 in 6). In line 6 for (670 in 3, &c.) read (660 in 3, &c.).

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inks from its starting point. Next we have line 8 and the school; this line starts at 2935 in 6 and ends at 1388 in 2. This line is also easily drawn, but it must be remembered that if any of the three lines, 3, 7, and 8, do not fit exactly there is something wrong with the work and it must be rectified before going any further. To put the school upon the plan is the next thing to be done. The longest line of the school is parallel to line 6 and is 18 links from it, and commences 3008 in 6 and ends 3132 in 6, and as each corner of it is a right angle, it is not a difficult task to draw it, seeing that the length of each wall is plainly marked thereon.

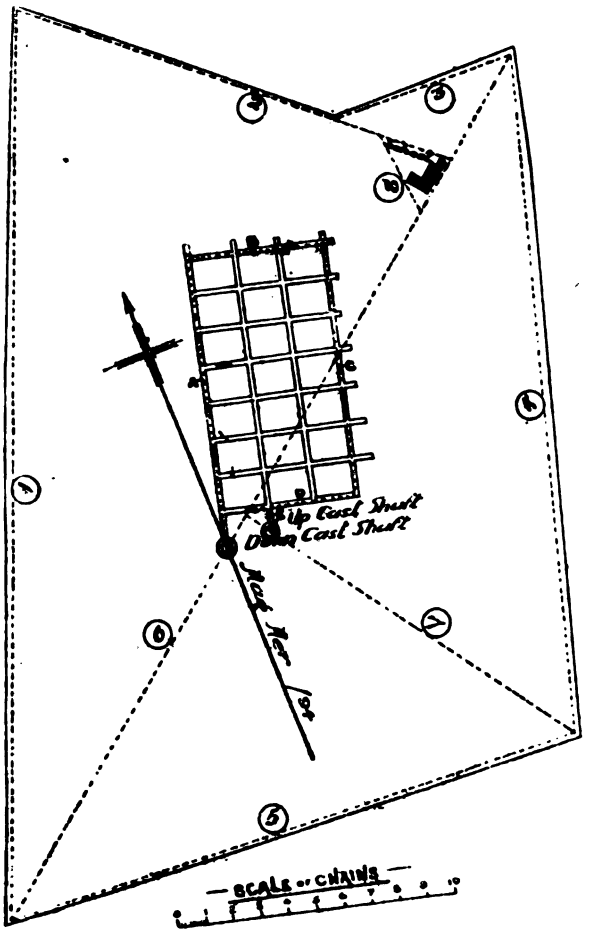

Fig. 1.

Now we come to the off-sets. At the commencement of line 1 we have an off-set of 14 links, at 1785 links we have another off-set of 32 links, and at the end of the line we have one of 10 links. It is advisable when first putting down the lines to mark the point at which the off-set was taken on the line, and what takes place at that point, for instance, when drawing line 1, mark the point 1785 and write in pencil—off-set 32 links—and at each end write in pencil—off-set 10 and 14 links respectively—or, say line 6, we point off —1544—centre of downcast shaft—at 1680—00 in 7—at 2935—00 in 8—at 3008—corner of school—at 3132—corner of school—at 3148—1622 in 2—at 3586, which is the end of the line,—660 in 3 and 00 in 4. And when the lines are inked over, and the magnetic meridian fixed on, it is finished, unless the underground survey has to be plotted upon the same plan, always remembering to erase all superfluous marks, and when the plan is finished it should be neat and clean. The magnetic meridian is fixed on the plan by means of a protractor. In this case line 6 is N53½E, so we place the protrac tor on line 6 with its centre on the centre of the downcast shaft, and so that the points N52½E lie immediately over the line, then the zero of the protractor is the magnetic meridian of the plan.

Now to plot the underground survey upon the same plan, we would mark off the bearings and number them while we have the protractor on it to ascertain the above meridian. Sheet B contains the information required to enable us to lay down on the plan the workings that have been surveyed. Line 1 bears N14½E, and is 1120 links in length and the road is 15 links wide; this is the easiest line to lay down, it only needs a line drawn from the centre of the downcast shaft to the point marked from the protractor, and the distance measured with a scale. At the examination it is requested to plot to a scale of two chains equals 1 inch, but as that is too large for this journal, I have reduced it.

If we refer to pages 25 and 26 and 308 of Vol. III. of *Mining*, we will find information there that will convince us that it would be an intrusion to give any further description of how to plot a survey. It is however necessary to note that line 2 of the underground survey does not commence at the extreme end of line 1, but at 1040 in 1, which is 90 links from the end; line 3 also commences at 485 in 2, which is 30 links from the end. The other lines also commence at a distance from the end of the preceding line, and through this quite a number of students failed at the examination.

* This is to a certain extent correct but the approximate bearings must be considered before it is known whether the first triangle is to the right or left of the main line.—Ed.

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Notes on the Prevention of a Gob Fire.*

In the Stockings Seam at —— Colliery.

By J. DENTON & GEO. J. BINNS.

THE large number of papers dealing with Spontaneous Combustion which have recently been contributed to the various branches of mining literature might appear to render further reference to the subject unnecessary, and indeed superfluous. Most of them, however, have dealt with the general features of this phenomenon and have entered into broad principles. The writers consider that on these points as much is at present known as is likely to be discovered, at any rate in the immediate future, and that knowledge will only be accumulated by records of threatened gob fires, with an account of the means utilized to deal with them. They therefore beg to offer to the members of this Society the following notes on an incipient gob fire in a seam which has hitherto not been noted for its tendency to fire spontaneously.

The Stockings Seam has been worked to a small extent at this colliery for some years, and neither here nor at neighbouring pits has it been considered a seam liable to spontaneous combustion. The Main coal, which is about 60 yards above is notorious for its liability to fire, and though heating has taken place in Stockings Stall before now, it has generally been attributed to Main coal slack which had been cleaned off the roads and gobbed.

The coal itself is a non-caking steam coal containing a somewhat large percentage of ash and sulphur, with about 49 per cent. of volatile matter.

The following is a section :—

	Ft.	Ins.
Black Shale	1	3
Top Coal	2	9
Bottom Coal	4	9
"Riggaries"	0	6
Clunch	0	10

The seam is worked by long stalls (60 to 100 yards) advancing to the rise with gob roads. Wooden brattices are built alongside to form the sides of the road. Along the face are alternating packs and wastes, the latter being 6 yards wide and the former 3 yards. The material for packing is obtained from the wastes, and the "riggaries" (a dark argillaceous material mixed with a considerable proportion of carbonaceous matter) and inferior coal are also used. The holing dirt and slack are thrown into the wastes. About 2 ft. by 2 ft. 9 in. of roof coal is left up in the face and over the packs, being got only in the gate and in the wastes. Formerly it was the practice to "cut" the wastes, *i.e.*, nick the roof coal alongside the packs, and so obtain it without blasting. Latterly, however, gelignite and water cartridges have been used, the result being that the roof of the wastes is more broken and a greater percentage of slack is formed, which is left in the wastes.

Appended is a sketch shewing the position of the workings where the heating occurred.

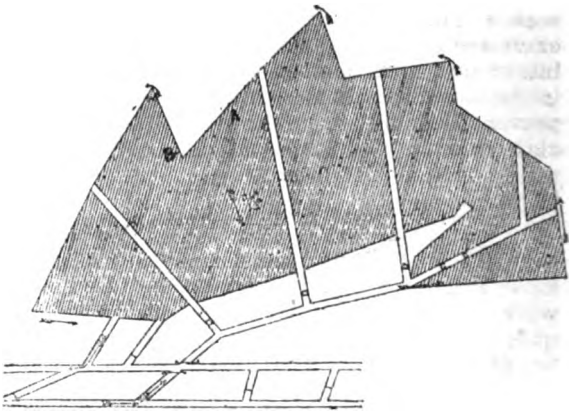

Fig. 1. *Scale 4 chains to an inch.*

The first indication was a gradual heating of the waste marked A (fig. 1), which was the second from the gate, there being two 3-yard packs and one 6-yard waste between. This was first noticed on September 1st, 1895, and two shots were fired after this date in the over-coal which was here 2 ft. 9 in. thick. By September 9th it became very warm, reaching a temperature of 88° Fahr. The sides of the packs in the waste were covered with drops of water and a peculiar white mould. The floor was cool, the heat being naturally greatest near the roof. The distance from the point of highest temperature to the face was 7 yards. Previous to September 1st, the stall had been standing eight weeks. The air current (shewn by arrows on the plan) swept along the face and was not directed into the waste. The "stink," so characteristic of the early stages of a gob fire, was as yet entirely absent.

It was decided to build off this waste and those near to it, and so a pack 9 ft. thick was run from the gate pack right along the face, in front of the wastes, and in a line with the front of the existing packs. The packing was composed of small stuff and sandstone from the roof of the Eureka coal, which lies 14 yards below the Stockings. The face was then worked forward a short distance, no over-coal being taken down at all.

On October 12th, 1895, the face having gone only a few yards from its original position, the "stink" began to work out of the pack, which had been put in front of the second waste, the packing itself being quite cool.

A clay wall 9 in. thick, was put in front of the old waste, and continued along the face towards the loose end. The end of the wall nearest to the

* From the Journal of the British Society of Mining Students.

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gate was turned into the pack a short distance, so as to get it up against small gobbing stuff, and thus prevent the stink being "soughed" along to the gate. The clay was sent into the stall in tubs and cut up on the spot by clay knives.

The wall was well beaten to ensure solidity with clay hammers, which are a kind of wooden mallet with a handle 2 ft. 6 in. long. Great care was exercised in handling the clay to avoid getting any bits of coal in it, as these invariably form facings in the wall, along which the stink can escape. To prevent this, brattice cloth was laid to place the clay upon when taken from the tubs. The wall was up to a good hard roof and down to the rock in the floor.

In front of the wall a good pack, 8 ft. thick, was built. The wall and pack were not finished to the loose end on October 12th, and before leaving work on that day blackdamp came off in such quantities as to extinguish a light held up to the top of the clay wall.

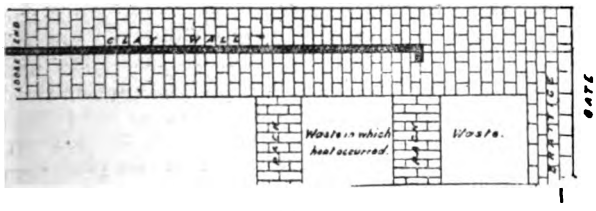

Fig. 2

Next day a mixture of foul-smelling gases, which extinguished a light, was perceived at the end of the clay wall furthest from the gate. On the 14th October, slight sweating and drops of water were perceived at the far end of the clay wall, which, with the pack, was then continued right along to the loose end. The position of the stall was then as shewn in the accompanying sketch (fig. 2).

To prevent the stink working out into the gate, all the man-holes on the left hand side of the gate were clayed up at the back, and a clay wall carried up with the stall between the brattice and the first waste, and lest it should spread into the next stall on the left, a similar wall was built along the loose end at the point marked B on fig. 1.

At the time of writing (January, 1896), no further indications of stink are apparent, and the clay walls are being carried up at each end of the stall. No over-coal was got in the wastes from October 12th, 1895, to January, 1896.

Answers to Correspondents.

T. J. B. (East Holywell).—Answer to geometrical question too abstruse to publish.

FIREMAN & WALTER KIRK.—Your letters to hand. Will insert next issue.

North of England Institute of Mining and Mechanical Engineers.

A GENERAL MEETING of members of this Institute was held in the Wood Memorial Hall, Newcastle-on-Tyne, on Saturday, April 25th, 1896, THOMAS DOUGLAS, Esq., President, in the Chair.

The SECRETARY read the minutes of the last general meeting, and in reporting the proceedings of the Council at their meetings on March 28th and that day said an honorarium had been voted to Mr. A. C. Kayll for his services in connection with the Explosives Committee, extending over five years and entailing a large amount of time in the experiments and drafting the report. Mr. J. H. Merivale had been appointed to represent the Institute at the next meeting of the Corresponding Societies of the British Association. It was also suggested that an excursion meeting should be held in Lancashire in June next if arrangements could be made.

The PRESIDENT alluded to the recent deplorable accident at Willington which he said had happened at a time when the members of the institute were congratulating themselves on their immunity from colliery accidents. Both the owners and agents of the colliery in question were closely associated with the Institute, and he proposed a vote of sympathy and condolence with the relatives of the unfortunate men who had been killed or injured, also with the owners of the colliery and the agents who had endeavoured to secure the safety of the men as far as possible.

Mr. T. W. BENSON seconded, and the motion was unanimously adopted.

COMPOUND WINDING ENGINES.

A paper by Prof. W. GALLOWAY was communicated on this subject and was followed by a short discussion in which the prevailing opinion was not in favour of compound engines for winding purposes owing to the small number of revolutions for each winding operation and the expenditure of steam in overcoming the difficulty of starting experienced with engines of this type.

FLAMELESS EXPLOSIVES.

Discussion of the Report of the Committee hereon was adjourned.

COAL CUTTING MACHINERY.

A paper by Mr. W. BLAKEMORE (Vice-President of the Mining Society of Nova Scotia) was read describing a number of coal cutting machines, among others the "Stanley Header," the "Mitchell Longwall," the "Ingersoll-Sergeant," and the "Yoch" machines. Summarizing the conclusions arrived at by the author, he considers it has been amply demonstrated.

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A Method of Renewing Defective Tubbing Plates.*

By G. Carrington Fowler.

BEFORE describing a method of renewing defective tubbing plates it will be as well to say a few words upon the circumstances which cause tubbing plates, after a lapse of some years, to become so weak as to give way, although when first fixed they were quite able to withstand the water or other pressures to which they were subjected.

Tubbing placed in a downcast shaft as a rule gives no trouble as long as the colliery lasts. This may also be the case in an upcast shaft, if it is fairly dry, and free from gases and vapours which injure iron. But at many collieries, especially old ones, the upcast shaft is the outlet for smoke and steam from the underground furnace boilers, or engines, and then if the tubbing is not protected from the acid fumes it will gradually corrode away. Pyrites, "brasses," or iron disulphide ($Fe S_2$) is, unfortunately, common in coal seams, and as coal mixed with pyrites is usually unmarketable, it is sent to the furnace or boilers. There a chemical change takes place; the sulphur is burnt off, forming sulphurous anhydride, which being absorbed by steam and moisture in the shaft forms an acid (part of which is deposited on the tubbing) and quickly shews itself by eating into any iron or steel with which it comes in contact.

Commercial sulphuric acid is made in a somewhat similar manner.

The writer has seen a quantity of flowers of sulphur deposited on ironwork in a fan drift, through which the smoke and steam from underground boilers passed; the ironwork was badly corroded.

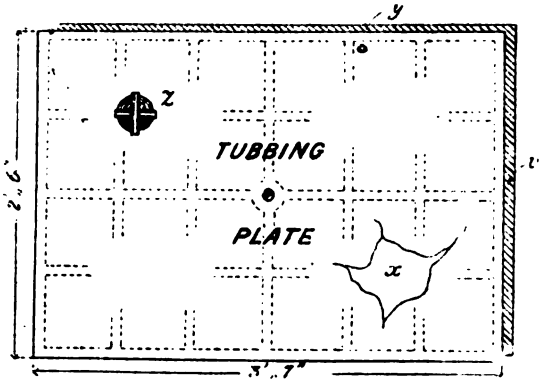

Fig. 1

The surface of a tubbing plate, which has been exposed for some years to the acid vapours of an upcast shaft, becomes soft like lead, and a knife blade can be easily pushed into it. This change in the formerly hard and brittle cast-iron continues, until the plate is so rotten that it can no longer withstand the pressure of water behind it, and the weakest point gives way, a piece of the plate being blown out, or else a large crack being formed. Fig. 1 (x).

As a tubbing plate is cast, it frequently happens that it is not uniformly strong. Perhaps there may be a flaw of only a few inches in area, and the rest of the plate quite good. In such a case, if the plate has been fixed in a shaft and it gives way at the flaw, it may be mended by driving in a wooden plug cut to a suitable shape to fill the hole. The plug is then split and wedges driven in, and again split crossways and wedged again, till the water ceases to flow. See (z) fig. 1.

If a defective plate cannot be made good in the above manner, it has to be taken out and replaced by two "match plates."

By looking at the sketches of a tubbing plate for a 7 ft. diameter shaft, and the two match plates to replace it, the reader will see how the difficulty of inserting the new plate is overcome. The top spigot (y) fig. 1, is not cast on either of the match plates. The larger match plate (A) fig. 2, has the usual side spigot (v), but plate (B) fig. 2, has none whatever. Thus, when the old plate is extracted, the two new ones can be easily fixed in its place.

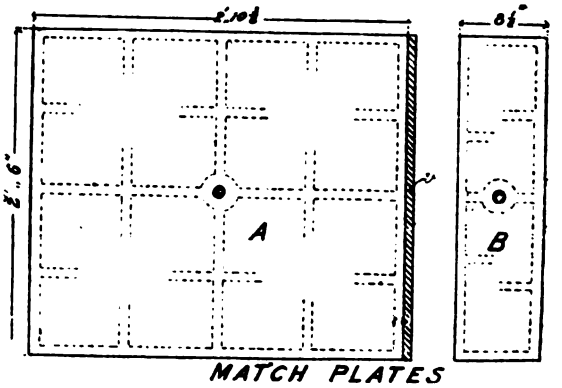

Fig. 2

It is sometimes a difficult matter to get out a broken plate, the flanges and ribs at the back holding it together even when the web is quite decayed.

If a plate has gone at one corner, as at (x) fig. 1, the sheeting and wedging round it is cut out with a cutting chisel, and the flanges and brackets broken by blows from a heavy hammer. By continuing the process of cutting out the sheeting and breaking the plate, it is at last completely taken out. All the old wedging is cleared off preparatory to adjusting the new plate.

* From the Journal of the British Society of Mining Students.

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When fixing the match plates, the larger one is first placed in the empty space with deal sheeting between it and the surrounding plates, and blocks of wood put at the back, if necessary, to keep it in place. Then the smaller plate (B) is inserted, with sheeting all round. Both plates are wedged with dry pitch pine wedges in the usual manner till the joints are water-tight, care being taken to keep the plates to the true circle of the shaft. Lastly, the centre holes are plugged.

The writer has seen defective plates repaired in the above manner at a depth of 90 yards from the surface.

Competition Questions.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before May 15th, 1896.

We invite readers to forward questions for this competition.

(1) What danger is to be apprehended when a fiery colliery, having workings to the rise and which has been drowned out, is being cleared of water by pumping?

(2) Describe with sketch what you deem to be the best, and most economical working, banking arrangements for dealing with 1200 tons per day from one shaft. Say depth of shaft is 600 yards, capacity of trams 10 cwt., and there are two seams being worked from the one mouthing.

[NOTE.—Award doubled for second question. There will be no award unless a good answer with easily understood sketch is submitted.—ED.]

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—S. Davies, Barrow Farm, Worsbro' nr. Barnsley.

Commended.—J. H. Berry, 36, Chatsworth Street, Walkden, near Bolton; S. Wane, 206, Pall Mall, Chorley, Lancashire; H. Hall, 15, Popular Terrace, Ryhill, Wakefield; J. H. Smith, High Street, Riddings, near Alfreton, Derbyshire; T. Hill, Crosby Villa, by Maryport, Cumberland; J. E. Keefe, Amble, Northumberland.

Question 2.—Thos. Hill, Crosby Villa, by Maryport, Cumberland.

Commended.—J. H. Berry, 36, Chatsworth Street, Walkden, near Bolton; S. Davies, Barrow Farm, Worsbro, near Barnsley; S. Wane, 206, Pall Mall, Chorley, Lancashire; T. E. Quail, The Cottages, New Bolsover, near Chesterfield; J. E. Keefe, Amble, Northumbdrland.

Question 3.—S. Davies, Barrow Farm, Worsbro' near Barnsley.

Commended.—H. Hall, 15, Popular Terrace, Ryhill, near Wakefield; J. E. Keefe, Amble, Northumberland; Thos. Hill, Crosby Villa, by Maryport, Cumberland; T. E. Quail, The Cottages, New Bolsover, near Chesterfield; S. Wane, 206, Pall Mall, Chorley, Lancashire.

The writer of the description of Ireland Colliery to whom an award was given last issue is Mr. W. CUTHBERTSON, Hartington House, Staveley, near Chesterfield.

The Harris Deep Navigation Colliery.

BY GILES JONES.

THIS colliery is situated near the Treharris station, on the Rhymney and Great Western Railways. It has two shafts of 17 feet diameter each; the downcast is 693 yards in depth to the 4 feet seam, and the upcast 720 yards to the 6 feet seam. These are the deepest shafts in S. Wales, approaching near the bottom of the northern trough of the coalfield. The sinking was commenced in February, 1873, and completed to the 6 feet seam in February, 1879. Mr. T. Foster Brown acted as chief mining engineer during the sinking operations, and continued for some time afterwards. Nearly three years ago the colliery was taken over by the "Ocean Steam Coal Company," and is now under the very able managership of Mr. J. P. Gibbon. The following is a section of the coal seams:—

Name of Seam.		Thickness of Coal. Ft.	In.	Depth from Surface. Yds.	Ft.	In.
Cefn Glas Seam.....	coal.....	1	0			
	clod.....	1	8			
	coal.....	2	6	106	2	0
Brithdir Seam ..... (2 Rhondda)		2	2	240	0	3
Abergorchi.....		2	4	468	1	6
Two feet nine.....	coal.....	1	0			
	rashing.	1	6			
	coal.....	1	6	687	1	6
Upper four feet		5	0	693	2	11
Six feet seam.....	coal.....	3	0			
	rashing.	0	10			
	coal.....	3	0	719	2	2
Nine feet vein	coal.....	2	11			
	rashing.	1	11			
	coal	5	0	745	0	1
Sump	Total depth ...			755	2	11

The height above the sea level at the top of the shaft is 500 feet.

The shafts are sunk through the pennant or middle coal measures from the surface to the depth of 2,000 feet; below this the lower coal measures come in, the zone dividing the two great series being the Gorllwyn seam. The hills on both sides of the valley in which the shafts are sunk are composed entirely of pennant. These hills are about 600 feet above the shafts, there is thus 2,600 feet of pennant accounted for, probably nearly the whole of the series. About three-fifths of the pennant is hard rock, more or less water-bearing; this will give some conception of the difficulties encountered in sinking through 2,000 feet of it. The first large feeder was met with at the Brithdir seam about 240 yards down, but long before this was reached water was given off in large quantities from the

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overflowing fissured rock, increasing with depth and culminating at the Brithdir seam, which had the effect of stopping the feeders from the rock. Another large feeder was met with at a seam of coal 468 yards down near the bottom of the 22-inch sets; the overlying fissured rock giving off large quantities of water as in the former case, which ceased as soon as the seam was reached. No tubbing has been inserted in the shafts. It was decided to raise all the water to the surface, thus giving in the future liberty to work any of the pennant seams of value without hindrance from water. Diamond drills were first used to drill holes for the sinking, and these were superseded by rock drills. A large compressor was erected to drive the drills by compressed air, thus giving a greater increased rate of progress as compared with hand labour. The shafts are walled throughout with bricks from 9 to 15 inches in length, and the walling varied in thickness from 18 to 24 inches according to the nature of the strata being passed through. The bricks were set with Aberthaw lime which hardens in water.

The area of mineral property leased from Colonel Lockwood and others is about 4,000 acres.

No steam whatever is taken down the shafts, only compressed air being used underground to actuate the hauling engines and pumps.

WINDING.—The engine at the downcast shaft has 54-inch cylinders, 7-feet stroke, direct acting to the spiral drum shaft. The engine is of the vertical and inverted order, each cylinder being supported on massive cast-iron standards; the spiral drum is 18 feet in diameter at first lift, and its greatest diameter is 32 feet. Each cylinder is fitted with 4 double beat valves, one 12-inch steam brake, one 7-inch reversing engine, and a foot brake. The steam pressure is about 45 lbs. The ropes are of the best plough steel, 6 inches in circumference, breaking strain 168 tons, duration of ropes from 12 to 18 months. Weight of coal, trams, cage, and rope lifted from bottom of shaft is about 20 tons. In each cage four trams of coal are raised on two decks—693 yards in one minute. The ropes are examined every morning by a specially appointed person, and oiled with rope oil several times during the week. The headgear of wrought-iron is 81 feet high from the plates to the pulley axles. The pulleys, 20 feet in diameter, are all of wrought-iron except the boss; the rim is composed of two layers $\frac{5}{8}$ inch plates, riveted together in sections; the arms are riveted to the rim, and secured by nuts and screws to the boss. Each cage is 12 feet in length, 4 feet in width, and 17 feet in height. Four shoes are fitted to one side of each cage, these run on two steel rails, and the rails are bolted to chairs fixed to byats of oak. These byats are 9 feet apart and form an open division between the cages and pump sides of the downcast shaft. The winding engine at the upcast shaft has two 42 inch horizontal cylinders, 6 feet stroke, cylindrical drum 18 feet in diameter, and double beat valves. It raises two trams in each cage on one deck from the 6 feet seam, and the cages run on steel rails at one side only.

BANKING ARRANGEMENTS.—The

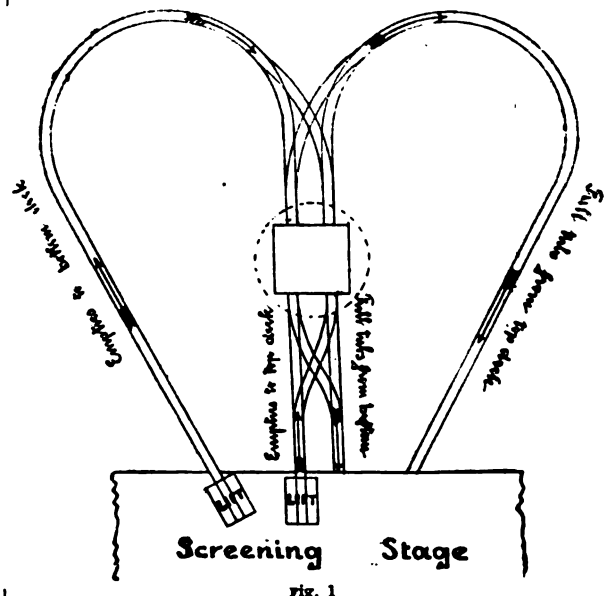

fig. 1

banking arrangements are somewhat peculiar. The tubs from the two decks of the cage are banked simultaneously on two stages; but they are run out from opposite ends of the cage for each deck (see fig. 1). The full tubs from the top gravitate along a circuitous route to the screening stage. The full tubs from the lower deck, however, gravitate in a direct route to the screening stage. To raise the empty tubs sufficiently high to allow them to gravitate back to both decks two lifts are employed. The empties return from the screening stage to the shaft in a direct route to the upper deck, and in a circuitous route to the lower.

AIR COMPRESSOR.—At the back of the same building as that containing the upcast engine, is placed the compressing machine, consisting of two steam cylinders, 42 inches in diameter, 6 feet stroke. They are immersed in tanks of water which partially cools the air; no cold spray is injected. The fly-wheel on a shaft behind the steam cylinders is 20 tons weight. Steam pressure 45 lbs., air pressure 60 lbs. at the receivers, of which there are four outside the building, about 30 feet by 6 feet. Air pipes 12 inches diameter run down the upcast shaft to another receiver placed on the 2 feet 9 inches landing, and from there down the return to the north-west districts, while pipes 8 inches diameter are run down to the 4 feet landing, and to the bottom of the 6 feet vein to work the west district and the six feet respectively.

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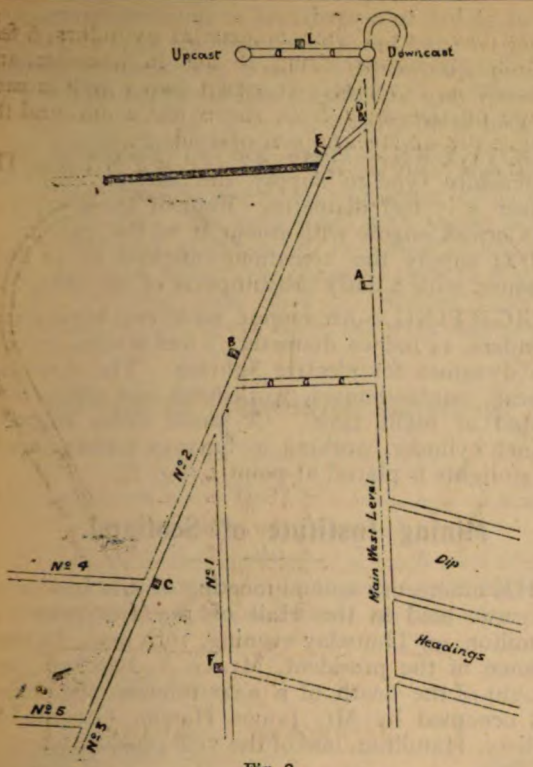

Fig. 2

HAULING ENGINES (*Four feet seam*).–Power is transmitted by compressed air to sixteen engines underground, also to four pumps. In the 4 feet seam two engines marked A and B on sketch No. 2 have two 20 inch cylinders, and two drums each 5 ft. diam. and geared. The engine marked A works the main west level and also the three dip headings marked on sketch. The engine marked B works the roads Nos. 1 & 2. The system of haulage with these engines is main and tail rope. The engine marked C has two 12 inch cylinders, two drums 3½ feet diameter, geared, and works the headings marked 3, 4, and 5. This engine works only one rope for each district; one drum works No. 3 and the other Nos. 4 and 5. The empty tubs are drawn up to the engines, the full tubs running back by gravity. Both decks of the cage are loaded at the same time, the empty tubs from the lower deck are raised by means of a vertical lift to the level of the tubs from the upper deck, and when a sufficient number has been fastened together they are drawn around the circuitous route (fig. 2) by two small engines D and E, with 7 inch cylinders and two feet drums to the ropes of A and B engines as required.

(*Six feet seam*).—The empty tubs from the upcast are first drawn by a small engine, 7 inch cylinder and 2 feet drum (marked A) around the circuitous route shown on No. 2 sketch. The engine marked B has two 10 inch cylinders and a pair of 3 feet drums. This engine works heading No. 1, and takes the coal from the other headings back to the shaft siding. The engines marked C, D, and E have 12 inch cylinders and 4 feet drums; F has an 8 inch cylinder and 3 feet drum, G has two 15 inch cylinders and a pair of 4½ feet diameter drums. These engines draw the empty tubs up, and the full ones run back by gravity.

PUMPING ENGINE.—An engine of the true Cornish type, condensing, but using steam at a pressure of 60 lbs. throughout the stroke is used for pumping. The cylinder is 100 inches diameter, 11 feet stroke (10 feet stroke in pit). The cast-iron beam weighs 40 tons. The cylinder has a steam-jacket in addition to a casing of brickwork. The engine has the usual steam, equilibrium, and exhaust valves. The pump rods at the top are two in number 12 inches square; by these seven forcing sets are worked, and one lifting set at the bottom, all being in a vertical line in the shaft. The capacity of the pumps in descending order is as follows:—Three forcing sets, each 26 inches diameter; two forcing sets, each 22 inches diameter; one forcing set, 14 inches diameter; two forcing sets, each 10 inches diameter. The average length of each forcing set is 89 yards, and the bucket lift is 9½ inches diameter and 67 yards long. The engine is in operation day and night at the speed of 2¼ strokes per minute.

	Tons.
The total weight of rods, plates, &c., are calculated to be	181
Weight on balance beam placed 240 yards from the top is 23¼ tons, front and back of the beam in the proportion of 2 to 3, increasing the lifting power of the beam to	35
Leaves weight upon the engine	146
Weight of water in the pumps	133
Surplus weight of rods to force water through the pumps	13

VENTILATION.—This is produced by a Schiele fan, 14¼ feet diameter, driven by an engine with 27 inch horizontal cylinder, 3 feet stroke on the second motion by a leather belt; the pulleys are in the ratio of 2·7 to 1, equals 170 revolutions per minute. Circulation of air 280,000 cubic feet per minute, with 3 inch water-gauge. A duplicate engine is provided and changed when required. The air is split at the bottom of the downcast, and then again split into the 4 feet seam. The different splits unite in the main return near the upcast, which is made under a strong rock roof above the 2 feet 9 inches seam, thus favouring ascensional ventilation. The air passes to the 6 feet vein through a cross-measure drift, shown in both sketches (figs. 2 and 3), and through a staple pit, and returns to the bottom of the 6 feet or upcast shaft. The return airways were kept in repair by means of timber until the present

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company took possession, but they are now all withdrawn and ripped up to the solid ground, leaving no danger for heavy falls to occur, or gas to lurk in the cavities above the timber, while the sectional area is larger.

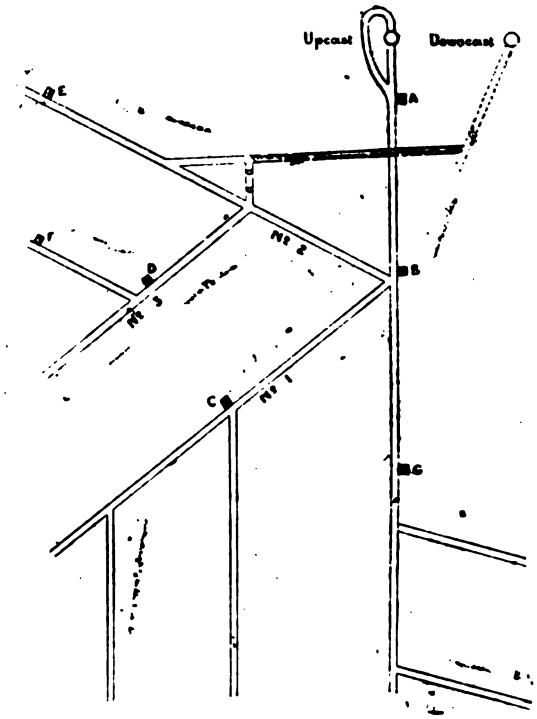

Fig. 3

The caps for the top of the upcast are of wood and conical shaped to allow room inside for the four corner chains of the cage, with a hole at the top for the rope to run through.

SYSTEM OF WORKING.—There are two different methods of longwall pursued; (1) the ordinary, where the gateways are 13 yards apart from centres, and the tubs stand in the gateway in loading; (2) the Nottingham method (fig. 4), where

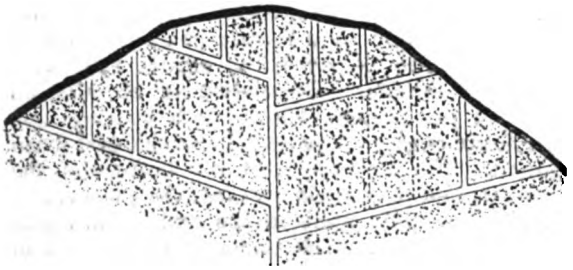

Fig. 4. *Scale.—146 yards to an inch.*

the gateways are 35 yards apart, from the gateways turns are laid on each side, and rails laid along the face. In each method the back workings are filled up close with rubbish; this is important as a measure of safety. The seams dip to the south about 2½ ins. to a yard, and as the northern trough is not far from here the seams come level and begin to rise southward. There are 2,000 workmen between day and night, and all lamps used are of the Cambrian type.

BOILERS.—There are 28 boilers of the Lancashire type to supply the surface engines, 30 feet × 7 feet diameter. Four of these supply the Cornish engine with steam at 60 lbs. pressure, and 24 supply the remaining engines at 45 lbs. pressure, with a daily consumption of 100 tons.

LIGHTING.—An engine with two horizontal cylinders, 14 inches diameter, 3 feet stroke, drives two dynamos for electric lighting. The screens, pithead, engine-houses, workshops and offices are lighted at night time. A small Soho engine, 6½ inch cylinder, working a dynamo underground for 40 lights is placed at point L (fig. 2).

Mining Institute of Scotland.

THE nineteenth annual meeting of this Institute was held in the Hall of the Institute, at Hamilton, on Thursday evening, 16th inst. In the absence of the president, Mr. G. A. Mitchell, on account of the death of a near relative, the chair was occupied by Mr. James Hastie, Greenfield Colliery, Hamilton, one of the vice-presidents.

The Secretary (Mr. Jas. Barrowman, Hamilton) read the annual report of the council.

The annual excursion in September had been to some of the new collieries in the Cowdenbeath district of Fife. In point of numbers it had been the most successful in the history of the Institute.

It had been found after the Committee on Mine Drainage had made some preliminary investigations that the inquiry would have involved so much work of a highly technical character, and have been attended with so great difficulty as to make it undesirable to proceed, at least in the meantime.

The report of the treasurer (Mr. A. Blyth) showed that while the year was commenced with a balance of £127 19s. 9½d., it ended with a balance of £134 3s. 2d.,—total receipts being £743 9s. 8½d.

There was a further discussion on Mr. R. W. Dron's paper on the "Southern Ayrshire Coalfields," chiefly bearing on their correlation with those of Lanarkshire. The Chairman closed the discussion with a vote of thanks to the author of the paper.

Mr. Robert Martin's paper on the "Treatment of Timber for Use in Mines" was further discussed, and elicited warm testimony as to the value of salted wood, especially in aircourses and return airways, as against non-salted timber. Its non-inflammable qualities as well as its properties in resisting rot were particularly dwelt on. In winding up the discussion, Mr. H. Aitken, Falkirk, the inventor of the process, said it had been forced

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upon him by fires in Middrie Colliery, Midlothian, and in one of his company's collieries, in Fife, the cost of which had been respectively from £60,000 to £70,000, and from £30,000 to £40,000. He emphasised the fact that every year fires were occurring in mines disastrous to human life as well as to property. He held that, with salted wood, while the coal might burn, the wood would not, and, amongst other references to fires in foreign mines, affirmed that that at Broken Hill, in Australia, would never have occurred had salted wood been in use. Mr. Martin was accorded a hearty vote of thanks.

In the absence of the author, the secretary read an elaborate paper by Mr. Dugald Baird, Leven, Fife, on "The Duty of Pumping Engines," the discussion of which was held over to a future meeting.

An invitation to attend the Mining and Geological Millenial Congress at Budapest, on the 25th and 26th September next, was favourably received.

Answers to Competition Questions.

GIVEN IN No. 9, VOL. IV.

METHOD OF WORKING.

(1) Describe the working of a mine with which you are acquainted. Give sketch or sketches of a portion of the mine, and show method of ventilating same.

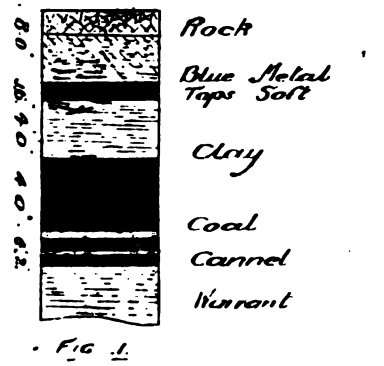

FIG. 1.

FIG. 2

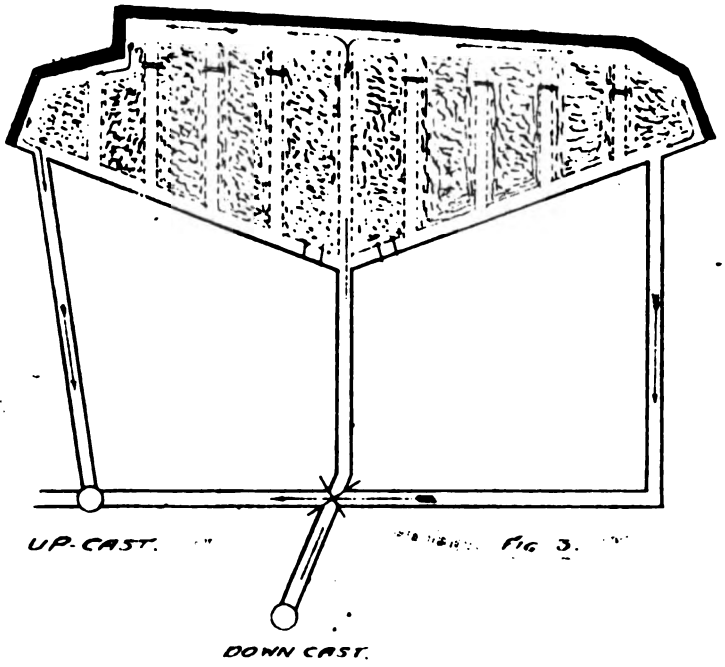

FIG. 3.

Answer.—Fig. 1 shows section of the Parkgate seam, and fig. 2 shows section of the Thorncliffe seam. These seams are worked nearly on the same level on account of the number of faults and the variation in thickness of the intervening strata, which in some parts is from 30 to 35 yards thick, and in others only a few feet. From both seams the coal is drawn to the surface from the Thorncliffe mouthing, and the coal from the Parkgate and upper Thorncliffe seams is dropped by means of a staple pit. Down this staple pit 700 tons can be dropped with very little trouble and expense; the depth of the staple pit is about 35 yards.

The Parkgate seam is worked on the longwall system, for which it is best suited, because of there being plenty of dirt for packing. The colliers hole or undercut in the dirt and inferior bottom coal, and this dirt is thrown into the gob behind them. They set and draw their own timber, and the night contractors rip and pack the gates up. Width of gates from 6 feet to 9 feet wide, ordinary 6 feet, and cross-gates 9 feet. Size of gate packs from 6 feet to 9 feet wide. Very little wood-packs are used, only in cases of emergency. Distance of gates apart 24 yards, so that every collier has 12 yards of a bank face to middle pack; the size of these packs is from 2 to 3 yards wide, according to circumstances. Cross-gates are turned off at a distance of about 80 or 100 yards, right and left, and the air travels along the main gate and splits

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at the face as per sketch (fig. 3). There are two colliers and two trammers employed in each gate. These trammers fill and tram their tubs to a pass-bye, and then they are either taken away by horses and boys or they are jigged down jinneys or trammed direct on to an endless rope.

The above system is also adopted in the Thorncliffe seam. The colliers use the Mueseler safety lamp, and the officials use the Jack safety lamp and the New Aluminum Mueseler type of Messrs. Mills and Sons, Newcastle-on-Tyne, which is a very light, useful, and sensitive safety lamp.

SAM. DAVIES.

THE ORDER OF WORKING SEAMS IN WATER BEARING STRATA.

(2) If three workable seams of coal occur in water bearing strata at equal distances apart, and within a depth of 20 yards, in what order would you work the seams, assuming the roofs to be similar in character? State your reasons.

Answer.—Probably the best method of working the above seams would be to first sink the shaft to the lower seam and then drive up through the measures to the upper one, and work it first, then the middle one, and the bottom one last. By doing this we minimise the dangers which arise when working such seams. For instance, if we were to work out the bottom seam first we would cause great destruction in the upper seams by the roof settling down, which would dislocate the strata between the seams, and if there was an extensive area of goaf in the lower seam the roof would in some cases settle down so much that the coal in the seam above would leave the roof. The working out of the lower seam first would cause the upper ones to be much harder and would cost more per ton for working them, and the roads would cause more expense and would be more difficult to keep open. I have had experience in working seams in close proximity, and in one case, where the bottom seam was extracted first, the roof of the upper seam when the coal was being worked out could not be kept up, as there was a layer of from 2 feet to 3 feet thick above the coal. When the coal was being taken down this roof came down along with it and caused much trouble. Great difficulties were experienced in the roads of the upper seam, which required a staff of men continually working on them to keep them open, and the coal was much harder and a larger price per ton had to be paid for the working of it.

By working the upper seam first the gas is to some extent drained off from the lower ones.

With long experience and close observations I am led to believe that the order in which these seams should be worked is as I have given.

The water bearing strata under the conditions mentioned would not alter the order of working the seams, as probably the working of the top seam would drain the water from the strata above before the lower seams were commenced, and the only increased water which the lower seams would have to contend with would be that which was lodged in the strata below the upper seam.

THOMAS HILL.

LONGWALL WORKING IN A THICK SEAM.

(3) You have a 9 feet seam of coal, with a fair roof, and only 1 foot of rubbish to work by longwall, the depth of the seam being 400 yards. Shew how you would work it, and explain your reasons why.

Answer.—The best, safest, and most economical system to adopt for working such a seam is in my opinion as follows:—(1) The first operation would be to win the coal by driving levels direct to the boundary as main roads for haulage, ventilation, and drainage. These connected at intervals by cross-roads, with 50 square yards of pillars between the levels. (2) After the boundary has been reached then work the seam "home" on the longwall system.

There are several reasons why I prefer this system, viz.:—(1) There is no packing material without extra labour and cost to get such dirt. (2) The thickness of such seam would require strong stone material to build packs with, if the seam was worked away from the shaft on the longwall. (3) By opening it out to the boundary and working back home the cost would be less. (4) The coal would be got in a better and safer way than by any other method, and the workmen would leave the gob behind them. (5) No packing would be required. (6) By driving first the proving levels to the boundary, firedamp would be drained to a great extent out of the coal and from the vicinity of faults. (7) There will be less expense in keeping the roadways in proper order and good repair. (8) The ventilation will be more satisfactory and maintained constantly on the working faces. (9) The danger when the barometer falls is reduced to a minimum, because there is no fear of the firedamp expanding and filling the gates up, as is the case when working longwall from the pit bottom to the boundary, on account of the roads going through the goaf. (10) There will be less coal lost. (11) Less material required, such as rails, sleepers, props, bars, etc. (12) Fewer roads to be kept in repair. (13) Easy supervision of the workmen.

SAM. DAVIES.

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'Mining'

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Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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South Wales Institute of Engineers.

AS recorded in our last issue, the thirty-eighth annual meeting of the above Institute of Engineers took place on Monday, the 20th ultimo, at Cardiff, under the presidency of Mr. ARTHUR J. STEVENS, Newport.

THE WESTERN PART OF SOUTH WALES COALFIELD.

Mr. THOMAS ARNOLD said that he had extended the longitudinal section No. 2, from Garngoch Colliery, near Gowerton, eastward through the Redhead and Worcester Collieries, near Forest Fach; the Graig Colliery, near Cwmbwrla; the Callands Pit, Morriston; the Copper Pit, Glandwr; the Marsh Pit and Round Pit, Llansamlet; the Scott's Pit and Birchgrove Pit, to the Duffryn Main New Pit, at Duffryn, Clydach, to join with the section prepared by Sir W. T. Lewis, Bart., and Mr. Reynolds in connection with their paper on the Neath mineral district, in 1870. He had also extended the plan to the eastward from Gowerton to Neath, and likewise prepared a sheet of vertical sections showing the seams of coals proved in the following collieries:—The Old Castle Colliery, Llanelly; Cae Colliery, Llanelly; St. David's Colliery, Llangennech; Broad Oak Colliery, Loughor; Gorseinon Colliery, Gorseinon; Mynydd Newydd Colliery, Llangyfelach; Callands Pit, Glandwr; and Duffryn Main New Pit, Duffryn, Clydach.

In preparing the vertical sections, the Six-feet or Graigola vein had been taken as a constant, and the other veins above and below plotted from this in each of the different sections.

Mr. H. K. JORDAN, referring to the changing character of coal, said that Mr. Huxham, at the last meeting, had suggested that anthracite was the result of the continuous progressive action of chemical affinity and decomposition in the coal itself, intensified by heat, and acting under the immense pressure of the superincumbent rock masses over countless ages of time, and further suggested that this action might have been brought into effect in one portion of the coalfield more than in the other, by the earlier elevation and partial denudation of the southern and eastern portions of the coalfield, whilst the more northern and western areas, where the coal was found to be more highly carbonised, remained buried and exposed to vastly longer continued pressure and consequent higher temperature, to be in its turn subsequently elevated and subjected to the action of denudation. But he did not think that hypothesis would hold water, and for this reason. If they took the uppermost seam of anthracite coal in that district, they found the thickness of strata which had been over that uppermost coal was less than the strata which covered the lowest coal in, say, Harris's Navigation, where the coal was not anthracite at all. Now, it was perfectly clear to his mind that if the Harris's Navigation coals, with nearly half-a-mile thickness of strata upon them, had continued down to the present time only partially altered, not converted into anthracite, whilst seams of coal which had had a lesser thickness upon them had been converted into anthracite, the theory fell through. It was a most complex problem, and one which he had been studying for a long time. One circumstance which had struck him in this connection was the absence, broadly speaking, of iron pyrites in the seams of coal in the westernmost part of the Welsh coalfield; whereas when they went into Monmouthshire, especially in the uppermost seams, they found flakes of iron pyrites very abundant indeed, and the same prevailed in the Forest of Dean. The conclusions which might be drawn from this fact he left others to determine.

Mr. J. MCMURTRIE suggested the appointment of a committee, consisting of authors of papers, to work out the correlation of seams. There would come a day, he remarked, and it was not perhaps far distant, when very deep sinkings in the neighbourhood of Llanelly would prove the seams of the Lower series, and then, if the seams were in good condition, there might be developed a very large coalfield indeed. As to the cause of the formation of anthracite, it had been attributed, in one instance, to disturbance, and in another to the immediate or approximate presence of igneous rock. So far as his own district was concerned—the Somersetshire coalfield—he was bound to say that neither of those suggestions would at all meet the requirements of the case. In his district they had the most bituminous of the seams lying at the bottom; they had those seams lying in the immediate proximity of the great anticlinal of the Mendip

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Hills, in the centre of which there was an immense development of igneous rock. The fact that those seams were the most bituminous in the entire coalfield went to prove that neither theory could account for the existence of anthracite coal. Another suggestion thrown out was that it might be due to a different kind of plant-life existing in certain parts of the coalfield, and a different vegetable deposit; but when they found the same seams highly bituminous at one point, steam coal at another, and anthracite at another part of the coalfield, it threw great doubt upon that theory.

Mr. ARCHIBALD HOOD thought the question of correlation was more difficult in the South Wales coalfield than in any other, because there were not so many well-defined landmarks as in some other coalfields. As to the cause which produced anthracite coal, notwithstanding the instance given by Mr. McMurtrie, he was inclined to the belief that anthracite had been caused by the action of heat in some way or other. In the west of Scotland, where there was a good deal of intrusive trap rock, the trap had generally destroyed the coal; it had not only expelled the gaseous matter, but it had also destroyed the carbon to a great extent. Where anthracite had been produced, the gaseous matter only had been expelled, leaving the carbon intact.

HYDRAULIC PUMPING PLANT.

Mr. James Barrow's paper on the above subject was further discussed.

CRUSHING STRENGTH OF BUILDING MATERIALS.

The next item on the agenda was the note by Professor ELLIOTT on the crushing strength of certain building stones and bricks. He did not claim that his paper was in any way exhaustive. He thought that the information conveyed by the tests under consideration was of more value concerning the bricks than the stones. He was at present conducting further experiments on stones.

UTILISATION OF WASTE HEAPS.

Mr. J. T. Fryer's paper "On the Utilisation of Waste Heaps by the Conversion of the Material into Concrete Bricks and Blocks" was next taken.

LOTHIAN COALFIELD.

The discussion of Mr. John Morison's paper on the Lothian coalfield, in connection with the development of the Newbattle Colliery, was adjourned to the next meeting.

AN IMPROVED SAFETY LAMP.

Mr. W. DAVIES, Llwynypia, submitted for inspection a very simple contrivance by which any attempt to open the lamp by the collier would be instantly followed by an extinction of the light. Replying to Mr. H. W. Martin, the inventor said it would cost 1s. 6d. to attach his contrivance to an ordinary Clanny lamp, and 1s. to attach it to a new lamp coming from the factory.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—B. Williams, 18, Griffiths Street, Mardy, Ferndale, R.S.O.

Commended.—A. Bailie, 47, Pitt Street, Newton, Glasgow; T. Rigby, 8, Prospect Place, Farnworth, near Bolton; J. T. Hall, Holy Moor Houses, Corkfield, Darlington, co. Durham; Hy. Bailey, Colesworth, near Tamworth, Warwickshire; S. Wane, 206, Pall Mall, Chorley, Lancashire; T. Rimmer, 38, Clarence Street, Newton-le-Willows; J. Smith, 528, Chorley Road, Westhoughton; Thomas Hill, Crosby Villa, by Maryport, Cumberland; W. H. Hardy, Green Hills, Eastwood, Notts; J. Hanner, 15, Victoria Place, South Shields; Joseph Hardman, 44, The Green, Haydock; R. Matthews, 29, Manor Street, Accrington; G. Daykin, 24, High Gnerney, near Bishop Auckland; S. Davies, Barrow Farm, Worsbro, near Barnsley; J. Laverick, Butterknowle, R.S.O., county Durham; R. Derbyshire, 45, Kearsley Street, Daisy Hill, Westhoughton; J. E. Keefe, Amble, Northumberland; J. T. Ward, New Street, New Tupton, Chesterfield; W. Ollerenshaw, 46, Grosvenor Street, Ashton-under-Lyne; James Davies, Clynderven House, Duffryn Place; G. B. Mossop, Valley View, Medomsley, R.S.O., county Durham; G. W. Hedley, Medomsley Edge, Medomsley, R.S.O., county Durham; W. H. Brierley, 220, Pearson Street, Stocksbridge, near Sheffield; J. Craggs, Butterknowle, Darlington; J. Marr, 95, Oakenshaw, Willington, Durham; G. Tweeddell, 9, Lloyd Street, Lemington-on-Tyne; E. Ward, Wharncliffe and East Gawber Colliery Co., near Barnsley, Yorkshire; H. Derbyshire, Kearsley Street, Westhoughton, near Bolton.

Question 2.—G. W. Hedley, Medomsley Edge, Medomsley, R.S.O., county Durham.

Commended.—James Skipsey, 25, Co-operative Terrace, Newsham, Northumberland; J. Lund, 14, Radcliffe Street, Woodhouse Lane, Wigan.

Question 3.—James Skipsey, 25, Co-operative Terrace, Newsham, Northumberland.

Commended.—S. Wane, 200, Pall Mall, Chorley, Lancashire; J. Laverick, Butterknowle, R.S.O., co. Durham; W. H. Brierley, 220, Pearson Street, Stocksbridge, near Sheffield; W. E. Leadbetter, 3, Front Row, New Bolsover, near Chesterfield; J. Davies, Clynderven House, Dyffryn Place, Macsteg, Glamorganshire; A. Bedford, Emley, near Wakefield; J. Hardman, 44, The Green, Haydock, near St. Helens; S. Davies, Barrow Farm, Worsbro, near Barnsley; J. E. Keefe, Amble, Northumberland; T. Hill, Crosby Villa, by Maryport; A. Bailie, 47, Pitt Street, Newton, Glasgow.

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The Lothian Coalfield and Recent Developments at Newbattle Collieries.*

By Mr. John Morison.

Continued from No. 11, Vol. IV.

THE general surface arrangements of the colliery comprise a winding engine with 40-inch steam cylinders, by 7-feet stroke, fitted with automatic expansion, and with the cylinders jacketed, An hauling engine, with 24-inch cylinders by 5-feet stroke, is placed at the surface, and works the underground haulage with the rope led down the shaft. Pumping plant is provided, consisting of three sets of engines and dynamos of equal size, the engines being 15½-inch cylinders by 33-inch stroke, running 90 revolutions per minute; steam pressure, 100 lbs. The dynamos are capable of an output of 60,000 Watts, at 600 revolutions.

The three motors placed in a house off the side of the shaft, at a depth of 430 yards, are connected to three sets of triple-crank vertical pumps, with 6-inch plungers, each set being complete, and the motors being arranged so that any motor may be attached to any pump in case of breakdown. Each set is capable of pumping 200 gallons per minute under a vertical head of 660 feet. The arrangement by which three sets of pumps, &c., were applied was adopted as providing the most convenient arrangement for securing against breakdown. The water which it was intended to provide against was 400 gallons per minute, so that one set of plant would constantly stand while the other two were in operation. All parts of engines, dynamos, motors, and pumps were alike and interchangeable.

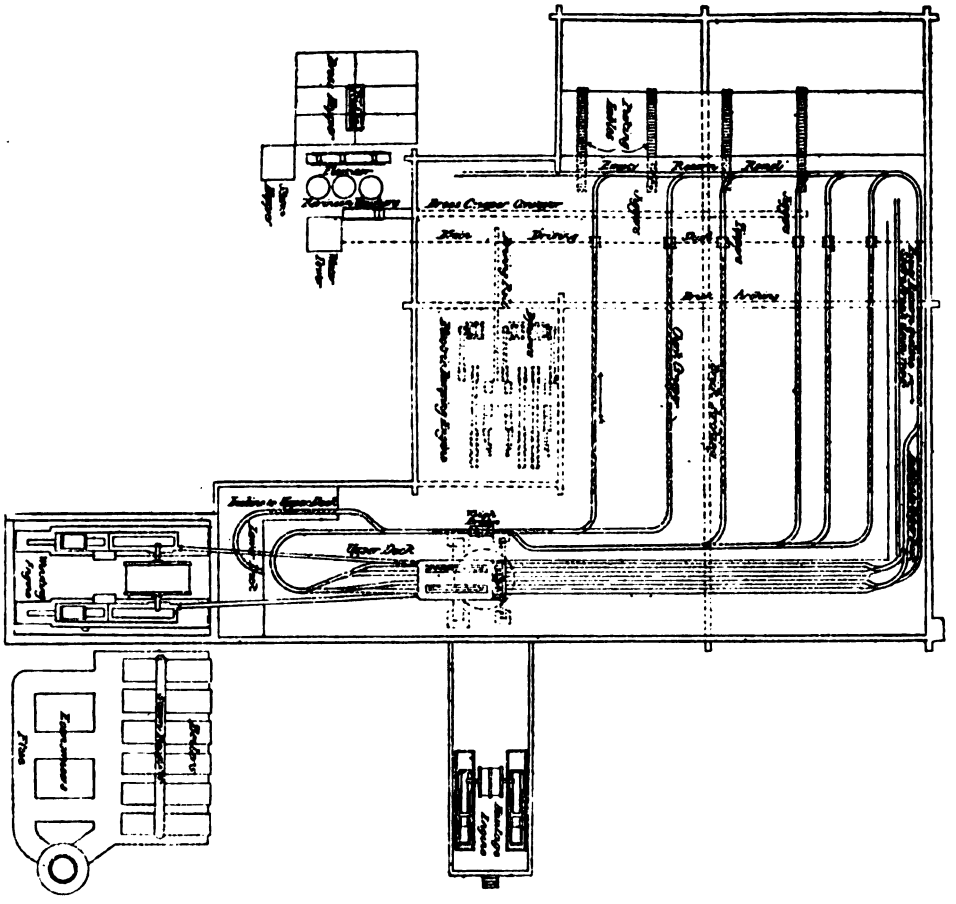

Fig. 2.

* From the Proceedings of the South Wales Institute of Engineers.

These pumps delivered up the shaft to a main pumping-engine which was placed at the bottom of another shaft. This engine is a triple expansion three-crank engine, working direct into three sets of double-acting plungers connected to the back end of the cylinders, the plant being capable of dealing with 800 gallons per minute at a depth of 900 feet, at 40 revolutions per minute.

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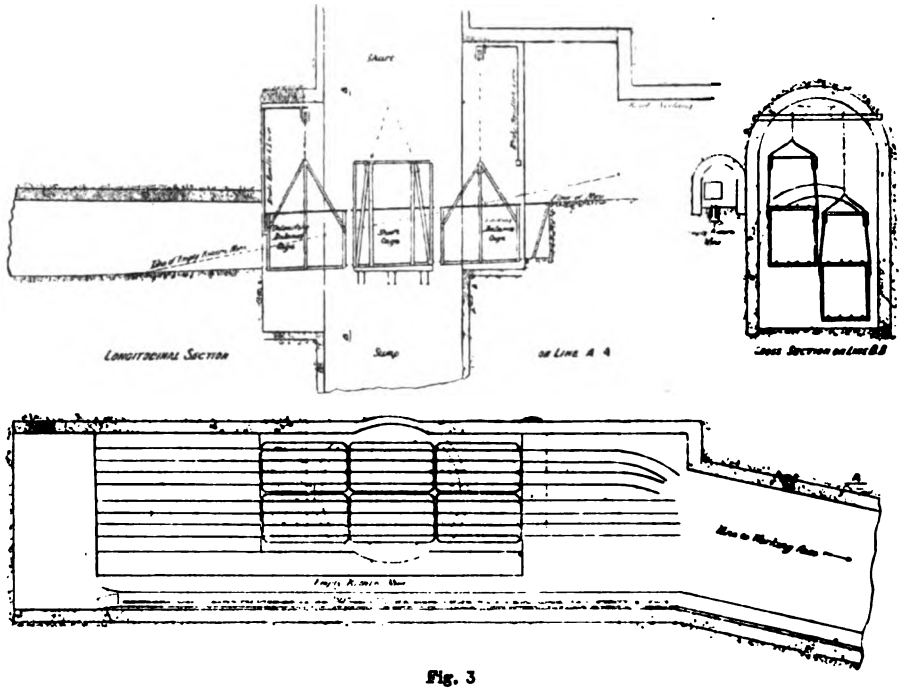

Fig. 3

The special features of the screening plant are the discharge of the tubs or trams from the cages, and their regulation to the tips (*see* Fig. 2). There are five classes of coal to be sent to their respective screens. The cage contains twelve tubs of from 9 to 10 cwt. capacity each. These are contained in two decks, six on each deck, and the cage bottoms are so inclined that upon the cage reaching the proper position at the top, whenever the catch is withdrawn a slight push by the banksman starts the tubs, which run down an inclined road to the weigh-table. At this point a creeper is arranged, which takes the tubs slowly over the table, a pause for each tub being also arranged. The tubs then pass on to another inclined road, off which switches, controlled by a boy who notes the class of coal, guides the different classes to their respective tips. The top of the shaft is provided with a double platform, which corresponds with the decks of the cage, so that both decks are loaded and discharged simultaneously. At the bottom this is also provided for by means of drop cages (*see* Fig. 3), which are loaded ready for the shaft cage descending. The method of working these cages is as follows :— The tubs are all brought in from the workings at one level. There are two cages corresponding with the cages in the shaft upon the full side. These are attached to each other in balance by means of a heavy chain over a pitched sheave, which is provided with a brake.

When the top deck of one cage is at the level of the mine, the bottom deck of the other is at the same level. Six full tubs are run into the latter, and it is allowed to drop. Other six tubs are then put on the upper deck, and when the shaft cage descends the twelve tubs are ready ; the floor of the drop cages being also inclined, whenever the catch is released the tubs run into the shaft cage. The cage in dropping raises the other cage ready for the same operation. On the empty side similar cages are provided, but the tubs on the bottom deck run straight through without stopping. The cage is then dropped by the weight of the six empty tubs remaining on it, and then run off, the catch returning them being automatically released when the cage lands in position by a projecting lever, which engages with a corresponding stop when the cage arrives at the proper position. The engine winds a cageload in 45 seconds. The drop cages are not yet in full working order, so that the time of changing is not yet ascertained, but it is expected that the time occupied in changing will not exceed 15 seconds, making the working capacity of the shaft a cage per minute. Balance of the load is effected by a counter balance rope of equal size to the winding ropes, which is looped from the bottom of one cage to the bottom of the other. There is no pulley in the bottom, the rope looping itself round without further provision than a small sheave on each side to steady it, and which the rope hardly touches. The balance rope is cable laid and composed of small wires, and is of similar make to a crab rope in order to secure flexibility.

(*Concluded.*)

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Coal-Cutting Machines.

A PAPER by Mr. W. Blakemore (Vice-President of the Mining Society of Nova Scotia) was read at a meeting of the North of England Institute of Engineers, describing a number of coal-cutting machines, among others the "Stanley Header," the "Mitchell Longwall," the "Ingersoll-Sargeant," and the "Yoch" machines. The following are the conclusions arrived at by the author as the result of experiments and working with the foregoing machines:—

Advantages.—(1) That in consequence of keen competition, and the necessity of increasing to the maximum capacity the output of mines, some mechanical means for cutting coal must be adopted in the near future.

(2) That one or other of these machines can be used with advantage, both on the score of efficiency and economy, for the purpose of mining coal.

(3) That it is possible to introduce the system into any well-regulated mine at present in operation, although it may not have been laid out originally with this intention.

(4) That it is practicable to work one district of a mine on this system without adopting it for the whole of the mine, and without interfering with the other districts, but it is not economical to do so, unless the whole of the district can be given up to it.

(5) That in the case of a new colliery just being opened, it is in the highest degree advisable unless the conditions of the mine are exceedingly difficult (such as an abnormally bad roof, and soft wet floor) to make provision in the first instance for the introduction of mining machinery.

(6) That in the case of an exceptionally favourable mine with strong roof and floor, it would be the best policy to lay down the plant from the commencement with the view of working the whole of the output by machinery, and the larger the output the greater the advantage of this system.

(7) That while there is an undoubted saving in the actual cost of the production, this is not the only, nor indeed the most apparent, advantage. The author considers that in the opening up of a new mine it would pay to put down a small plant for the purpose of driving all the headings, even if it were taken out again, and not used for the ordinary mining of coal, so great a saving can be effected in the cost of this class of work, and also in the speed with which it can be performed. The writer has no data to guide him in this statement, but during his own experience of more than twenty years, the opening up and development of a new mine to a capacity of 1,000 tons per day within a year is without parallel, and this was effected at the Dominion No. 1 mine. Such a result must be accredited entirely to the use of mining machines.

(8) A further advantage is the larger tonnage of coal which can be produced from a given area or length of working-face. This increase the writer estimates at double the production of hand picks, and it is hard to calculate the extent of the saving in a large mine due to this fact. It means half the length of working-face, and probably not more than 75 per cent. of the roads and air-ways to be constructed and maintained for any given output.

(9) There is a further advantage of a very material character in the fact that a so much larger output of coal can be secured with the same number of men, and there are times when under sudden stress of demand this becomes a very important matter, as it enables one to respond more promptly and without difficulty to a sudden demand, the elasticity of the system being much greater than is possible under the older method.

(10) The writer would also class with the advantages the fact that, whilst working at a price which is satisfactory to the employer, the machine-operator can earn considerably more money than by the hand-picks. This soon popularizes the machine, and creates contented workmen. It is also a move in the direction of all modern mechanical substitutes for arduous and unnecessary manual labour, which ought soon to be as obsolete in the mine as it is in a well-equipped modern iron and steel works.

Of course, some of these advantages are not as apparent as in a densely populated country with surplus labour generally at hand; but in a new country, or even in a new district, it would be impossible, within a short time, to collect sufficient men to open up and develop a large mine. We all know, under such circumstances, the experience of collecting men together a few at a time, and making what appears to be snail-like progress, while capital is being expended, and the mine is eating its head off with interest; and under any circumstances, if there be a justification for opening up a new mine, there must be at least equally sufficient reason for opening it up as quickly as possible.

Disadvantages. — (11) There are certain disadvantages that should be enumerated. Among these are the addition of a considerable sum to the capital outlay, and consequently the fact that in times of stagnation there is much more capital lying idle; the difficulty and opposition which has to be encountered in introducing a new method; the necessity for conducting the general operations of the mine upon a different system.

It must also not be forgotten that mining by machinery entails in some respects a great deal of additional worry and anxiety upon the managing-staff. Nothing could be simpler than that a workman should carry his picks into the mine with him, or obtain them at some station, do his work, carry them out, and there is an end of the matter; but cutting by machinery means an almost daily lengthening of pipes in each working-place, the keeping of a large array of hose and fittings in working condition, the sharpening and supply of the picks for machines, which, owing to the harder slow struck, are damaged or worn out much quicker

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than a hand-pick; the supply of duplicate parts, and doing of constant necessary repairs to the machines themselves. All these details involve much labour and attention, and unless the staff is thoroughly well organized, and every detail carefully attended to, satisfactory results cannot possibly be achieved. A successful result, however, as the members will observe, is entirely a matter of organization. There are no insuperable difficulties, and when once a mine has settled down to this system, it is quite possible to run along smoothly and efficiently; in the introduction of the method, however, much trouble lies.

Balancing the advantages with the disadvantages, the writer has no hesitation in saying that the former largely predominate. The importance of the subject cannot be over-estimated. Like most Englishmen the writer had seen but little coal cut by machinery at home. At first he entertained all the prejudices which might be expected from an old countryman against a radically new system. After watching it carefully and handling it in all departments he is a convert, and does not hesitate to say to-day to his *confrères* at home that it is the system of the future, and he believes of the near future, and that for many reasons, in addition to those which he has stated above, and which will become increasingly apparent and powerful as time progresses, the coal mines of Great Britain will be compelled before long very largely to abandon the primitive method of cutting coal by hand. Of course, these observations can have no reference to mines where, owing to the superincumbent pressure or texture of the seam, little or no under-cutting is required; but so long as headings have to be driven and strong seams of coal have to be undercut and sheared, a machine will do this more efficiently and economically than a hand-pick. He considers that the matter has passed beyond the experimental stage.

Competition Questions.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before May 29th, 1896.

We invite readers to forward questions for this competition.

(1) What quantity of water could be raised, and from what depth, with an underground pumping engine having a 20in. cylinder, 4ft. 6in. stroke, double-acting working, a 10in. pump also double-acting, the effective steam pressure on the piston being 40lbs.?

(2) Show a plan of endless chain system of haulage with branch roads; also of driving the chain from the surface by means of ropes down the shaft?

(3) A seam of coal crops on a hill top; 200 yards due south of the outcrop, and 160 feet below it it crops again; a borehole is put down 500 yards due west of the latter place, and finds the coal at a depth of 1,200 feet below the first outcrop, what is the true strike and dip of the seam?

The Engineering of Collieries,

Being a Treatise on Colliery Machinery, Appliances, and Constructions.

By T. A. O'DONAHUE.

Commenced in No. 9, Vol. III., continued from No. 9, Vol. IV.

TIPPLERS (continued).

THE difficulty experienced in effecting a regular discharge of the coal, with tipplers actuated only by the force of gravity, has led in recent years to the adoption of power-driven tipplers.

The Humboldt Friction Tippler.—Figs. 69, 70, 71 illustrate a power-driven side tippler made by the Humboldt Engineering Company, Cologne. It consists of the usual circular end pieces and connecting bars, which form the cage for the tram. This is supported by four friction wheels on loose bearings, three of which (A A A) are placed immediately under the cage; the fourth, c, which is considerably less in diameter, is placed a little to one side. The

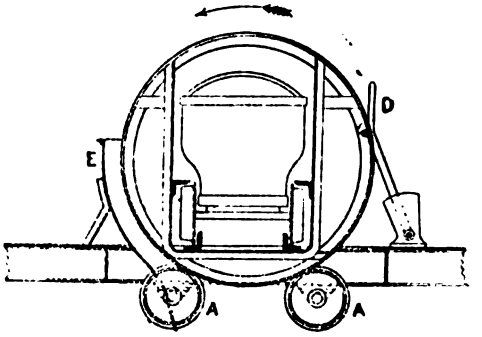

Fig. 69.

driving wheel B is situated at the front end of the tippler, and is keyed to the same shaft as the pulley F, to which power is transmitted from the engine. The front wheel of the cage, which rotates on the driving wheel B, has a recess, G cut in its edge at a point which is immediately above the driving wheel when the cage is in its normal position

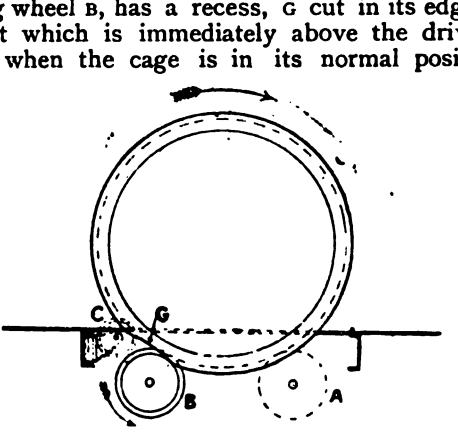

Fig. 70.

for receiving a tram, and although the driving wheel continues to revolve, this breaks the contact with the cage, which therefore remains at

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rest. The use of the small friction wheel C will now be apparent, it being necessary to preserve the stability of the cage when the driving wheel is not in contact. The rails for the reception of the tram

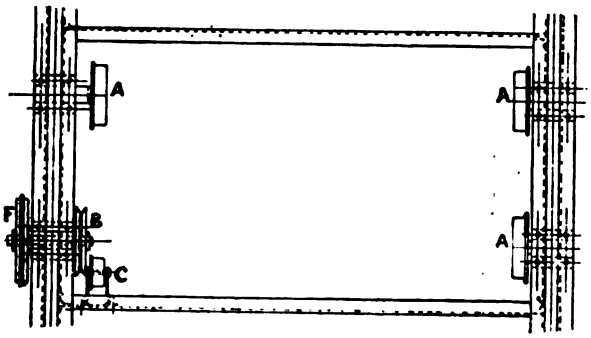

Fig. 71.

in the tippler are a little to the discharging sides of the tippler, so that when a full tram is put in there is sufficient power through the force of gravity to commence the revolution, and carry the recess G past the driving wheel, when the latter completes the revolution. To prevent the tippler starting before required, and to ensure its being stopped in the correct position, a lever D is provided which has a hook near the upper end which engages on a stud in the end of the tippler. The lever is withdrawn to start the tippler, and is then allowed to fall back so as to again engage on the stud at the completion of the revolution. This is an advantage over most power-driven tipplers, as they have not only to be started by hand but have also to be stopped.

To minimise the breakage of the coal, an apron E is provided to catch the coal discharged at the beginning of the revolution. There is also a cover to the cage (omitted in sketch) for use when the coals are piled above the top of the tram to prevent discharge until the apron is reached.

The Humboldt Geared Tippler.—This tippler has been designed for trams of large capacity, and acts on the same principle as the one previously described; but motion is transmitted to the tippler from the driving wheel by gearing to prevent slipping with the heavier load. The driver consists of a toothed wheel which gears with a large toothed rim on the tippler, thus ensuring a positive action. Contact is broken between the geared wheel when the cage is at rest by omitting a few teeth in the large wheel on the tippler. This type of tippler has been supplied to several collieries in this country.

The Wood-Burnett Simplex Tippler.—This tippler (fig. 72) is manufactured by Messrs. Coulson & Co., Spennymoor, Durham, and special attention is directed by the makers to its simplicity of construction and fewness of parts. It is a throughway side tippler, consisting of the ordinary cylindrical cage, which rests on four friction rollers or wheels. Two rollers A and the adjacent roller at the back end (back and front view being identical except the

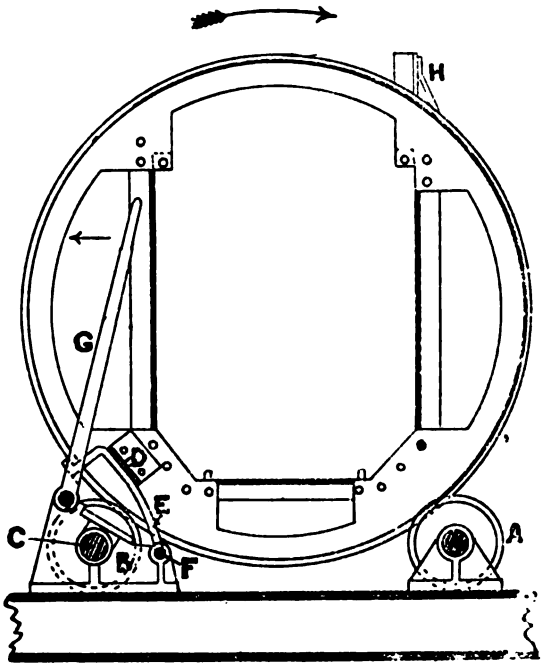

Fig. 72.

omission of the lever (G) at the back end) are on loose bearings; the other two (B) are keyed on a shaft (C), to which power is applied in any suitable manner. When the driving wheels (B) are in contact with the circular ends of the cage the tippler rotates in the direction shown by the arrow, being also slightly assisted by the full tub, which is a little nearer to the discharging side of the cage. To stop the cage when the revolution has been completed two brake pieces (D) are fastened to the cage —one on each end—in the position shown. A bent bar E is placed at each end of the tippler, and one end is hinged at F and the other rests on a cam on the shafting to which the lever G is keyed. The shafting to the lever extends to the back of the tippler, so that the cams are keyed to the one shafting. When the lever is in the position shown, the brake pieces, at the completion of the revolution catch the inclined bars E, and lift that side of the cage sufficiently to clear the driving wheels. To start the tippler the lever G is pulled in the direction of the arrow, thus lowering the bar E, and allowing the cage to again come in contact with the driving wheels. The lever is immediately turned back to its original position, and the cage stops automatically at the completion of the revolution. A wrought-iron plate H is fitted to the discharging side of the tippler to enable the coal to be tipped gently on to the screen shoot. The tippler is in use at the following collieries:—South Hetton, Murton, Springwell, South Brancepeth, Eldon, &c.

The same firm also make the Wood Burnett Positive Tipper, which, as its names imply, instead of being driven by friction, is driven by means of

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tooth gearing, or by an endless flat link chain from a lower driving pulley, and passing round a sproket rim at one or both ends of the tipping frame, provision being made for instantaneous stopping and starting. It is stated that one lad can tip from 800 to 1,000 tons per day with this tippler. It has been supplied to the following collieries:—South Hetton, Murton, Lumpsey Mines, Hutton Henry, Nunnery, &c.

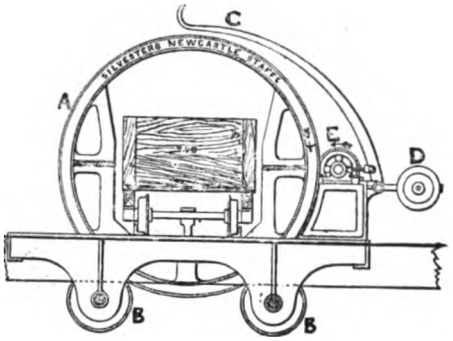

Fig. 73.

Silvester's Tippler.—This tippler (fig. 73) is also of the throughway type. It consists of a cylindrical frame A, which rests on four friction rollers (B B), all of which are on loose bearings. There are two driving wheels (E), one for each end of the tippler, and these are keyed to a shaft which rests on a sliding carriage, and to which power is transmitted by belting. To start the tippler the end of the lever C is pressed down, and as the lower end of the lever is connected to the driving shaft bearing, the wheels E are put in contact with the tipping frame

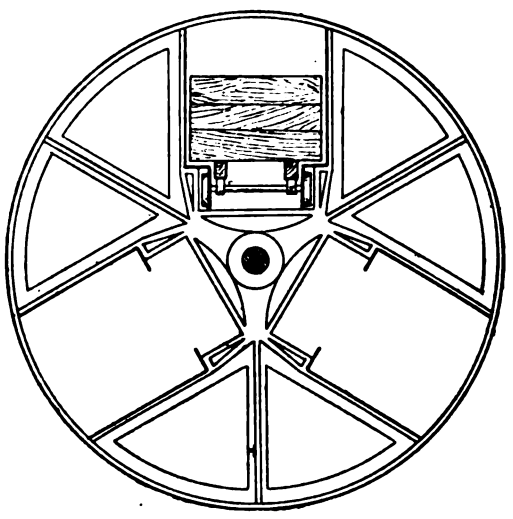

Fig. 74.

and cause it to revolve. Immediately the pressure is taken off the end of the lever C, the balance weight D falls slightly, and thus draws back the sliding pulleys and stops the tippler. There are wrought-iron plates on the side which guide the coal and breaks its fall. The writer is assured that, with trams of 10 cwt. capacity, 100 tons per hour can be tipped by one man. This tippler is in use at Chatterley Whitfield Colliery.

The Pelsall Tippler.—This tippler (fig. 74) is automatic in its action. It consists of a large cylindrical frame, which is keyed to a central shaft on which it rotates. It holds three tubs at one time; a full tub is run in at the top, a second tub has its contents partly tipped, and the third is empty, and will next be the uppermost to be exchanged for a full one. The coals in the full tram, and in the one which has partly discharged its contents, supply the motive power, and its motion is controlled by a brake on the rim of the circular frame.

(*To be continued.*)

The Lubrication of Colliery Engines.*

By G. E. J. McMurtrie.

IT is a question whether the dearer cylinder oils at 2s. 6d. to even 3s. per gallon, such as the Vacuum and Kellog's oils, are not quite as economical as the cheaper at 1s. 9d. or 1s. 6d. Their much greater body and higher firing point should make up for their difference in price.

Its use is the best test of an oil, but high firing point, heavy body, and freedom from gummy matter, appear to me the best guides short of this. Some oils are refined to such an extent that the principal lubricating powers are gone.

Since 1891, the use of tallow in the cylinders has been gradually reduced by myself, by the substitution of sight feed lubricators in the place of the old tallow cups, until tallow is now alone used on two donkey pumps and a third small engine for cutting chaff. Sight feed oil will shortly be substituted here.

It is manifest that even if we grant that tallow is as good a lubricant as cylinder oil, yet it is clear that the sight feed method of lubricating cylinders is the correct one, and far preferable to the old tallow cup, which every now and then was opened to let a certain portion through, this being probably blown out in its entirety with the first stroke of the engine, and little good done. The great objection to tallow is to be found in the corrosive action of the acids it contains, on the engine fittings with which it is brought in contact. My fortnightly store sheets prove that one halfpennyworth of sight feed oil will do the work of one pennyworth of tallow.

On the larger engines sight feed lubricators of various types are used; on the smaller, the modified and much cheaper form of drop feeds.

It certainly appears to me that the lubrication should be regulated by the revolutions of the engine,

* Abbreviated from communication to the Journal of the British Society of Mining Students.

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as is sometimes done, and not by regulating the oil outlet and steam inlet. The latter system is no doubt correct for engines with a sensitive governor, but for ungoverned engines with varying speeds the former system should be the best.

For oiling bearings, slides, and all the small moving parts of the engine, a mixture of two engine oils has been used till lately, now, a spindle oil has been substituted. The lubricators used are of various types. Stauffer's lubricators and grease are now being substituted for this oil with advantage after careful tests.

Nothing will shew better than these tests how very largely the consumption of oil is dependent on the good sense of the enginemen, which fact must tell against the adoption of expensive oils, as if such be used extravagantly or wastefully the cost of lubrication will be very heavy.

A No. 10 Stauffer's lubricator, supplied by Trier Bros., was placed on the one winding drum bearing, and the other bearing lubricated as before with engine oils. After a lengthy test, the engine oil proved the more economical of the two, and Messrs. Trier Bros. were written to that effect. Their reply was that we must be using it wastefully, and they advised us to reduce the quantity used. Thereupon the engineman was instructed to use less, and to reduce it to the point when the bearing just began to heat.

This was done, and an immediate economy of 30 per cent. was shewn over the engine oil.

Stauffer's lubricators are fitted to the four cams of the jigger screens, which, previously, we could not keep cool at times, necessitating their frequent replacement; to the drum shaft and one crank pin of the winding engine, and to a bearing of an air compressor that gave much trouble. All are now cool, and sometimes a pound lasts these seven lubricators a month, sometimes a fortnight. An economy of probably 40 or 50 per cent. is now being obtained, and we are quietly fitting up all the engines with these small economisers. A further advantage of this heavy grease is that everything is clean and nice, and there is no oil thrown about.

A third economy effected is the substitution of petroleum for naptha for shaft work, and for lighting the colliery shops and various lamps. An antiquated form of tin plate lamp, which frequently exploded, has been replaced by the Wells' unbreakable lamps, which are an economy in spite of occasional waste at the tap, are absolutely safe, and will stand larger currents in the open air and shafts. Petroleum is inflammable enough, but naptha is worse; while the latter costs 1s. per gallon, the former could, till lately, be got at 5d. to 5¼d. per gallon.

The economy has been somewhat aided by the adoption of electric light for lighting the screens, in place of the Wells' lamp, burning petroleum.

The following table gives the cost of lubrication for the year 1895, at a colliery known to me:—

	Quantity.	Average price for the year.	Value. £ s. d.	Average quantity used per working day.
Vegetable Oil	1733 gals.	6d. gal.	43 6 6	9·07 gals.
Tar	1646 ,,	1·18d. ,,	6 17 2	8·62 ,,
Tallow	144 lbs.	26/6d. cwt.	1 4 7	·54 lbs.
Truck Grease.	310½ ,,	2·26d. lb.	2 18 5	1·62 ,,
Petroleum ..	655 gals.	5·52d. gal.	15 1 7	3·42 gals.
Sight Feed Oil	180 ,,	1/5·1d. ,,	12 16 7	·94 ,,
Lubricant....	37 lbs.	9d. lb.	1 7 8	·19 lbs.
Grosvenor Oil	113 gals.	1/9d. gal.	9 17 9	4·73 pts.
Spindle Oil ..	148 ,,	1/8d. ,,	9 0 0	4·52 ,,
Air Valve Oil.	8 ,,	2/- ,,	0 16 0	·33 ,,
Colza Oil	50 ,,	2/2·5d. ,,	5 10 6	2·09 ,,
Seal Oil.....	57 ,,	2/0½d. ,,	5 16 3	2·38 ,,
			£114 13 0	

Number of days worked 191

Average Cost per working day 12/-

The total quantities used, the average price per gallon or cwt. of each, the total value of each used, and the average quantity of each used per working day, together with the total cost per working day, are given.

The number of days worked is given, and the consumption and cost is based on this, no allowance being made for the play days, as it is impossible to accurately obtain this. Consequently, the consumption and cost per working day appears greater than it really is.

Vegetable oil and tar are used in equal proportions for oiling the trams or tubs. Tallow has almost disappeared. Air valve oil, which was specially used for lubricating the air valves, and was considered freer from gummy substances and less likely to clog the valves, has been replaced by spindle oil, which appears to act equally well. Colza and seal oils are used for various engine lamps, and for the lamps of officials and certain other men to whom oil is allowed.

The engines lubricated comprise the following:—

A pair of 27 in. horizontal winding engines with 5 ft. stroke, winding 650 tons in eight hours. A 30 in. vertical beam engine with 6 ft. stroke, driving a 28 in. horizontal air compressor. A 28 in. horizontal steam cylinder with 5 ft. stroke, driving a 28 in. air compressor. A 57 in. Cornish pumping engine with 8 ft. 6 in. stroke, in house. A single 20 in. horizontal engine with 4 ft. stroke. A vertical 21 in. engine with 7 ft. stroke. A 14 in. horizontal engine with 2 ft. stroke. A pair of 9 in. hauling engines with 1 ft. 6 in. stroke. A pair of 14 in. hauling engines with 2 ft. stroke; and five small underground donkey pumps and a dynamo.

It is not claimed that this is an exceptionally good lubricating cost, but it is stated that the costs are normal and not likely to be reduced, unless similar oils can be obtained at lower prices. The consumption is also believed to be as little as is consistent with efficient lubrication.

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Science and Art Department.

MINING EXAMINATION.

The examination in this subject lasts for three hours.

First Stage or Elementary Examination.

INSTRUCTIONS.

You are permitted to attempt only *seven* questions. Not more than four questions may be selected from Section A, not more than three from Section B, and not more than three from Section C. No candidate may answer questions from Section B *and* from Section C.

The value attached to each question is given in brackets after the question.

SECTION A.—GENERAL.

1. What tools are required for boring shot holes (*a*) by jumping and (*b*) by single-handed drilling? (15)
2. Sketch and describe two methods of securing a large level with masonry. (15)
3. Explain the construction and uses of the capstan and shear legs of a pumping engine shaft. (15)
4. Compare the weights and strengths of a round wire rope 3½ inches circumference and a flat one 2¾ inches by ¼inch, both of best plough steel quality. (15)
5. What are the best methods of preparing timber for underground use? (15)

SECTION B.—COAL.

6. What is anthracite and where is it principally found? (15)
7. What natural systems of division are found in coal seams, and how does their position affect the working? (15)
8. What is long wall working and how is it applied (*a*) in a flat seam and (*b*) in one with a high dip? (15)
9. Explain the uses of the barometer, thermometer, anemometer and water-gauge in controlling the ventilation of mines. (15)
10. What special regulations should be observed in mines subject to sudden outbursts of gas? (15)

SECTION C.—METALLIFEROUS.

11. What is the general rule for determining the direction of the heave when a load is thrown out by a cross course? (15)
12. What is the composition of Wolfram, how does it occur, and for what is it used? (15)
13. What minerals are usually associated with lead ore in lodes (*a*) in granite and (*b*) in limestone country? (15)
14. How would you arrange a long stroke pump-rod in a shaft when the angle of inclination increased 15 degrees? (15)
15. Describe the principle of dressing minerals by jigging, and show how it is done (*a*) by hand and (*b*) by mechanical appliances. (15)

Second Stage or Advanced Examination.

INSTRUCTIONS.

You are permitted to attempt only *seven* questions. Not more than four questions may be selected from Section A, not more than three from Section B, and not more than three from Section C. No candidate may answer questions from Section B *and* from Section C.

The value attached to each question is given in brackets after the question.

SECTION A.—GENERAL.

21. Describe and illustrate the construction of the Ingersoll Rock Drill. (30)
22. What are safety explosives, and what precautions are necessary to ensure their acting without flame? (30)
23. A pit is 16 feet in diameter and 200 yards deep. What is the weight of rock (shale and sandstone) excavated, and how much land will it cover when tipped as a square pyramid 32 feet high? (30)
24. Give some figures, with dimensions and weights, of steel bars and arches for use in levels in the place of timbers. (30)
25. What is the Riedler system of construction of pumps and compressors, and what are its advantages? (30)

SECTION B.—COAL.

26. What properties are most valued in steam, gas, and coking coals respectively? (30)
27. Describe the Lancashire system of working steeply inclined coal seams. (30)
28. On a seam dipping south 1 in 6, what will be the gradient of a road driven N.E., and would such a road be suitable for horse traction? (30)
29. What methods have been adopted for systematically keeping down the dust in coal mines? (30)
30. What is meant by *equivalent orifice*, and how is the term applied in discussing the efficiency of ventilating machines? (30)

SECTION C.—METALLIFEROUS.

31. When the country of a lode changes from one rock to another, how is the ore-bearing character affected? Give some examples. (30)
32. Describe a method of working a large lode with complete filling or packing in the stopes. (30)
33. When a lode is dipping at a low angle, how can the contents of a stope be determined from the plan and vertical section? (30)
34. What are the most important zinc ores, and the principal localities producing them at the present time? (30)
35. Describe the principal slime dressing machines in which a percussive action is employed. (30)

Honours Examination.

INSTRUCTIONS.

You are permitted to attempt only *six* questions.

The value attached to each question is given in brackets after the question.

41. Give an account of the Lancashire and Cheshire coal field, noticing points of technical mining interest. (70)
42. How is tin ore found in the following districts:—
    (*a*) Cornwall, Camborne, and St. Ives districts.
    (*b*) Tasmania.
    (*c*) Perak.
    (*d*) Bolivia (70)
43. Describe the construction of a self-tipping skip suitable for a 2-ton load in an inclined shaft. (70)
44. Sketch an iron tub for carrying 10 to 12 cwts. of coal, giving dimensions and details of construction, including the arrangements for lubrication. (70)
45. Describe the Poetsch method of shaft sinking, noticing specially the points upon which its success depends. (70)
46. In a working dipping 1 in 10 water accumulates at the rate of 3,000 gallons per day at a point 500 yards from a shaft. How would you deal with the water? (70)
47. Describe in detail the construction of an 18-inch plunger-lift of 10-feet stroke, with its intake 200 fathoms deep. How much water would it lift at five strokes per minute, and what power would be required to work it? (70)
48. How would you construct a dam in an abandoned shaft to prevent the influx of water from shallow to deep workings? (70)
49. Sketch out a plant for disposing of the output of a shaft drawing 100 tons of coal per hour, using 10-cwt. tubs and two-decked cages. The coal to be hand-picked and screened, but not washed. (70)
50. What plant would you specify for producing 30 tons of black tin per month from 2 per cent. tin-stuff, supposing calcining to be necessary? (70)

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Answers to Competition Questions.

GIVEN IN No. 10, VOL. IV.

SHOT-FIRING.

(1) Assuming you were asked to fire a shot in coal, the holing being 3 feet and the shot hole 3 feet 6 inches, what would you do?

Answer.—I would not fire the shot until the holing was carried on another foot, but if it was not possible to hole more than 3 feet I would bore another shot-hole 2 feet 6 inches deep; it is always best to have the holing-in at least 6 inches deeper than the shot-hole. My reason for not firing a shot in coal when the shot-hole is deeper than the holing under the coal is because the charge would be in the solid, and the least line of resistance to the explosive would be in the direction of the shot-hole. In most cases of this sort the result would be a blown-out shot, which would be very dangerous in a fiery or dusty mine. BEN. WILLIAMS.

MENSURATION.

(2) You have a level plane 200 yards long, over which it is proposed to construct a railway. It is required to raise the embankment 2 yards above the level plane at one end and 5 yards at the other; the top of the embankment is to be 20 feet wide and the slopes 1 in 1. Calculate the cubical contents of the earth required for the embankment.

Ans.—It will be necessary to split the embankment into two parts, and to take each separately for the purpose of calculating the cubical contents. We will take the central contents, disregarding the sloping sides for the first part and the two sides for the second part. In the central part we shall have the frustum of a wedge: length 600 feet, width 20 feet, and heights 6 feet and 15 feet. For the sides, if we place them together, we shall again have the frustum of a wedge: length 600 feet, width and height 15 feet at one end and 6 feet at the other. A slope of 1 in 1 = an angle of 45°, and the angle at the base = 90°, therefore in the triangle the other angle must = 45°. The perpendicular = 15 feet, therefore the base = 15 feet. Consequently on placing the slopes together they will form a square of 15 feet at one end and 6 feet at the other. We can now therefore easily arrive at the cubical contents of the embankment.

Central part:—

One end for 1 ft. in length, $20 \times 15 \times 1 = 300$ cu. ft.
Other end ,, ,, $20 \times 6 \times 1 = 120$,,

420 ,,

$420 \div 2 = 210$ cubic feet.

Or by taking the mean of the heights—

$15 + 6 = 21 \div 2 = 10{\cdot}5 \times 20 = 210.$

$\therefore 210 \times 600 = 126{,}000$ cu. ft.

Two slopes:—

One end for 1 ft. in length, $15 \times 15 \times 1 = 225$ cu. ft.
Other end ,, ,, $6 \times 6 \times 1 = 36$,,

261 ,,

$261 \div 2 = 130{\cdot}5$ cubic feet.

$\therefore 130{\cdot}5 \times 600 = 78{,}300{\cdot}0.$

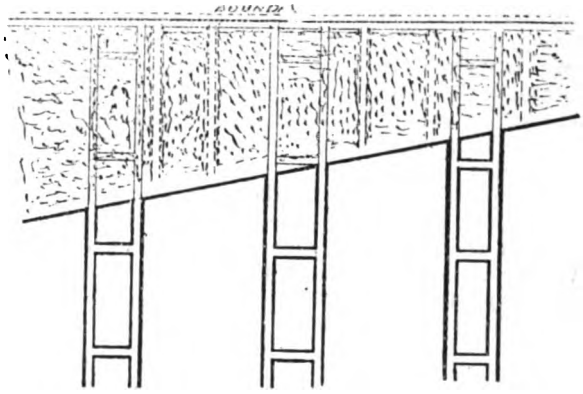
$\therefore$ Central part and two slopes = 204,300 cu. feet.

$204{,}300 \div 27 = 7{,}566\frac{2}{3}$ cubic yards.

Say, 7,600 cubic yards of earth required for the embankment. GEO. W. HEDLEY.

MODE OF WORKING.

(3) You have a seam of coal, 4 feet thick, 200 yards deep, with a soft wet floor and with a shaley roof 2 feet thick, which falls. Describe with sketch how you would work it.



Answer.—Before deciding upon any method of working, it would be necessary to have more data than is given in the question, but assuming that other conditions were favourable I would probably give preference to the longwall method.

Some writers lay down as a hard and fast rule that in order to work longwall successfully a hard bottom is absolutely necessary, but my experience teaches me that in some cases a soft bottom is a great boon in working this method, nor is a little water objectionable in some cases.

The method I refer to is longwall, with the holing done in the underclay, and, providing that the underclay is not too thick, this is about the cheapest method that can be adopted, and, moreover, the percentage of round coal is greater by this method than by any other, which is a very important factor.

In this case I would prefer the "working home" method, providing that a limited output can be made to suffice until some near boundary is reached by the "fast" places, or if the output can be made up for a time from some other seam.

In driving the "fast" places to the boundary

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I would take up the soft thill to the first hard "parting," and also take down the two feet of shale, which would give me a good height in all main roads, these being driven in the direction most suitable for drainage and haulage.

After having driven the "fast" places to the boundary I would open out a long face and commence at once "working home." The men stowing the dirt got from the holing themselves, and the two feet of shale which would be taken down in the drawing roads would serve to build in additional packs, and as this method of working does not require such strong packing as is needed in "working out," the dirt from the holing, together with the shale which is taken down, would afford ample support for the roads until such time as a new road was needed, when the old roads are of no further use, and consequently no further cost in their maintenance is involved.

I would keep the gateways as far apart as possible, and drive no headings excepting those which are required at the outset to open out the working face, but having all branch roads "rid" through the goaf, thus avoiding interference with the line of face. The distance apart of the branch roads being determined by the circumstances of the mine.

In addition to the packing put in by the men, the working face might be secured by props or chocks according to circumstances, and all back timber to be removed as the face advances, thus allowing the roof to gradually settle and keep the crush from the working face.

The accompanying sketch shows this system of working. JAMES SKIPSEY.

Correspondence.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

GEOMETRICAL PROBLEM.

Sir,—*Re* the problem I sent you a few weeks ago. If you have not received a proper geometrical solution yet, I will be happy in sending you my method of doing these problems—a method which I have submitted to mathematicians of some repute, and who have informed me that, although these questions have been done for ages by algebra, they have never seen one solved geometrically, and testify also to the correctness of my method, which, as far as I know, is entirly new. JAMES SKIPSEY.

[Shall be pleased to receive you solution.—ED.]

WIRE ROPE FORMULA.

Sir,—I would feel greatly obliged to any correspondent who would kindly show how the constant numbers, 2·5 and 1·2, are got in the following formula in finding the circumference of a winding rope. Thus, C =

$$\frac{2{\cdot}5}{10} \sqrt{\frac{\text{Load in tons}}{\text{Depth of pit in fathoms}}} \times 1{\cdot}2 \times 2240$$

MENSURATION.

(1) What will be the size of a pond to hold 1,000 gallons of water, the depth to be 6 feet, and the slopes to be 1 in 2.

THE VERNIER.

(2) Show by a sketch how the vernier of a compass is read to minutes. WALTER KIRK.

[A detailed description of the Vernier will be found in No. 26 of vol. 2.—ED.]

Sir,—I should be much obliged if some of your correspondents would explain the two following questions in your next issue:—

PUMPING.

(1) What methods are adopted for counterbalancing and utilizing excess weight of the water in a single-acting pumping engine?—I am at a loss to understand to what this excess weight of water refers.

ARITHMETIC.

(2) Estimate metallic and money loss which resulted from 1000 tons of tin stone, loss in dressing being one half unit per ton, and price of white tin being £91 per ton. A.B.C.

THE FLEUSS APPARATUS.

Sir,—In reading an account of the sad calamity that occurred a few weeks ago at Brancepeth Colliery, near Durham, whereby twenty valuable lives were lost by an explosion, the question arose in my mind the practicability of using the Fleuss apparatus in cases of this kind. This apparatus, I understand, is an ingenious invention for the purpose of enabling persons to penetrate into places charged with noxious gases, and is supplied with oxygen to last for three hours; there is also a lamp in connection with it which lasts for four hours; the breathing apparatus weighs about 28lbs., and is carried on the back of the explorer; there is no long pipes in connection with it to impede the progress of the wearer. Now, as we are all aware who are connected with mining, when an explosion takes place of any magnitude the ventilation is either partly or wholly destroyed owing to stoppings and doors being blown down, which requires a good deal of time to restore again sufficiently to enable explorers to proceed. Now the question that presented itself to my mind was whether the men who might be nearest the shaft, and who would likely to be affected by the after-damp, could not be reached sooner by using this apparatus in the event of an explosion, provided of course that the roads were sufficiently open to admit of explorers getting in, that is as regards falls of stone.

I may say that I have not seen this apparatus, and my object in writing was to ascertain whether any of your readers had seen it, or seen it used, as I am sure it would be very interesting to have some information respecting the working of it. Seeing that the Fleuss apparatus has been invented for such a humane object, and yet does not appear, so far as I know, to have come into practical use, I should like very much to know the reason why. NIL DESPERANDUM.

[The Fleuss Respirator has been successfully used on several occasions, and has been the means of saving life.—ED.]

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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On the Testing of Ventilating Fans.

By W. Fairley, F.G.S.,

Author of the "The Practice and Science of Mining Engineering."

(Specially written for "Mining.")

ONE of the most important subjects to which the mining student and engineer can direct their attention is the construction and effective work obtained from pneumatic machines in their application to mine ventilation. The dangers and inconveniences arising from the use of furnaces in producing a ventilating pressure have at length become so fully recognised that their application at new mines are scarcely entertained.

In the construction of a fan the three main points to be kept in view are—first cost, effectiveness, and durability.

The effect of the fan rotating at the top of an upcast shaft is to cause a vacuum dependent on the speed of the rotation, and the amount of the perfection of its working; in this way the air near the fan becomes attenuated, and the air flows from the mine to the fan in such a volume as depends on the two conditions mentioned, as well as on the area of the equivalent orifice of the mine. The degree of perfection with which the fan works is generally spoken of as the

MANOMETRICAL EFFICIENCY

of the machine, and as this is an important factor in the consideration of the question, it is necessary to enter into some explanation about it. The manometrical efficiency means the work done by the fan as compared with what it should do when running at a certain speed. The rule for calculating the theoretical depression produced by a fan—that is, what it should produce—is based on the laws of gravitation, by which we learn that the force of a falling body, expressed in feet of air column H, is equal to half the velocity squared divided by g (32·2), hence the rule applicable to a fan rotating at a uniform velocity is $H = \frac{V^2}{g}$ from which we get the ready way of obtaining the depression expressed in inches of water-gauge, w; velocity squared multiplied by ·000458 = inches of water, or $V^2 \times ·000458 = w$. Thus, if a fan has a periphery velocity, or tipspeed of 81 feet per second, the water-gauge it should produce is equal to $81^2 \times ·000458 = 3·00$ inches (see table of the theoretical depression produced by fans at p. 324 of *The Practice and Science of Mining Engineering*). If in this case the water-guage placed in the fan drift reads 1·62 inches, then the manometrical efficiency of the fan $= \frac{1·62}{3·00} = ·54$, or 54 per cent.

If K = the manometrical efficiency of the fan, the air flowing is according to $\sqrt{2K}$, then the quantity that will be delivered per revolution by a fan 35 feet diameter, and having a manometrical efficiency of ·64, working on a mine with an equivalent orifice of 30 square feet will be

$$·65 \times 35 \times 3·1416 \times \sqrt{2 \times ·64} \times 30 = 2426$$

cubic feet; but if the fan was perfect, and gave an effect due to the theory, then the quantity per revolution would be

$$\frac{\sqrt{2 \times 1} \times 2426}{\sqrt{2 \times ·64}} = 3032 \text{ cubic feet;}$$

the quantity in all cases being according to the square root of twice the manometrical efficiency $= \sqrt{2K}$, a rule which is proved to hold good in all the experiments, so far as noted by the writer, recorded in the transactions of the mining institutes (*vide* table at p. 160 *et seq* in the book mentioned).

The theoretical quantity of air in cubic feet per minute, that will pass, is calculated by the rule $q = ·65 \times \sqrt{2K} \times a \times 60 \times V$, where a = equivalent orifice, and V = tipspeed in feet per second.

The manometrical efficiency of fans now in use at the mines of Great Britain varies from ·36 to 1, we have read somewhere of a fan giving an effect of 1·06, or 106 per cent., but this comes from the fact of using 2 g instead of g as the divisor in the rule, in which latter case the efficiency would only have been ·53. The higher the manometrical efficiency of the fan, the better will be the mechanical efficiency, if the same engine be applied to work it. As the effective depression of the fan improves, so will the modulus of the engine working it improve, because with an increased manometrical efficiency of the fan there is an increase of the load—in passing over the same distance—put upon the engine, therefore the object of the engineer should be to construct a fan that would obtain as high a manometrical effect as possible. The actual

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QUANTITY OF AIR

that passes out of the mine is usually measured in the fan drift, by taking repeated observations of carefully adjusted anemometers, the speed of which is noted at various parts in the transverse section of the drift. From these different readings an average is struck, and the speed multiplied by the area gives the quantity. It may be noted by the way, that this part of the work requires to be done most carefully, as it will be found, even by using the most accurate instruments, that it is not an easy matter to arrive correctly at the exact quantity of air in motion. To calculate the area of the drift is generally an easy matter,—to ascertain the velocity is the most difficult. The reading of the

WATER-GAUGE

usually placed in the fan engine-house should show the measure of the ventilating pressure, or the difference of the density between the outer air, and the return air of the mine. This pressure, resulting from the working of the fan, indicates the resistance met with by the air in passing through the mine —minus the pressure necessary for putting the air in motion. It is necessary to mention this here, although it is usual to take the water-gauge of the fan house as representing the pressure due to the resistance of the mine, ignoring the pressure required to put the air in motion, which forms but a fractional part of the whole pressure. A tube is conveyed from the water-gauge to the return air in the fan drift; so that one leg of the instrument s subjected to the pressure of the air of the mine, and the other to the outer air. The pressure, as indicated by the water-gauge, multiplied by the quantity of air passing gives the

POWER IN THE AIR,

so that if 126,923 cubic feet of air pass out of the mine under a pressure of 1·5 inches of water-gauge by the working of the fan, then the horse-power producing it amounts to $\frac{126923 \times 1{\cdot}5 \times 5{\cdot}2}{33000} =$ 30 horse-power, which may be considered as the load attached to the engine working the fan. The *usual* way of testing a ventilating fan is to compare the power in the air with the

POWER APPLIED TO THE ENGINE

working the fan. The way of calculating the power in the air has been shown. In ascertaining the power applied to the engine, the pressure of the steam is obtained by taking diagrams by an indicator, this multiplied by the area and speed of the piston gives the power; for example, an engine whose cylinder has an area of 1256·64 square inches, worked at a steam pressure of 20·25 lbs. per square inch, and running at a speed of 369¼ feet per minute, will have a horse-power of $\frac{1256{\cdot}64 \times 20{\cdot}25 \times 369\frac{1}{4}}{33000} = 284{\cdot}73$. If in this case the horse-power in the air amounted to 142·36, then the mechanical efficiency of *the fan* would be said to be ·5, according to the usual way of reckoning. This however cannot be rightly considered as the mechanical efficiency of the fan, but rather that of the engine working it, or more correctly the mechanical efficiency thus obtained is not the result of working the fan only, but of working the whole machinery, engine and fan together. Indeed the correct test appears to be to compare the power applied with the power obtained, which will give the percentage of the efficiency of the whole machinery.

The student, the writer thinks, will find it to be an interesting question to explain why a Waddle fan with a manometrical efficiency of ·54 should give a mechanical efficiency of ·65 (*vide* examples 89 and 97 in table at page 164 of the book mentioned), and why a Rateau fan, whilst giving a manometrical efficiency of ·94, should only give a mechanical efficiency of ·468.

Competition Questions.

We make an uniform award of 2s. 6d. to the sender of the best answer to each of the questions given. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered.

Envelopes to be marked "COMPETITION," and to reach us before April 12th, 1896.

We invite readers to forward questions for this competition.

(1) Supposing you find the water-gauge very low, and another time you find it very high, in either case what would you think was the matter, and where would you go first?

(2) Assuming you are in charge of a drift or stone-head, and you have three shot holes, one in each side and one in the middle, and there was 1½ lbs. of powder in each of the side holes and 3 lb. in the middle one, which would you fire first?

(3) A pit is 150 fathoms deep, 250 gallons of water are given off at 40 fathoms, and 400 gallons at bottom. Engine to go 18 hours in the 24. Find size of engine, pumps, rods, plates, and bolts, and give the length and kind of lifts you would fit up.

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Notes on Conveying-Belts and Their Use.*

By THOMAS ROBINS, JR., NEW YORK CITY.

ABOUT six years ago the writer had occasion to visit a large magnetic iron ore concentrating plant, and then saw for the first time rubber belts being used for conveying purposes. These belts were from 20 inches to 30 inches in width, and some of them were as long as 500 feet between centers. When I spoke of the enormous amount of material they handled with a small expenditure of power, the superintendent assented, but at the same time complained that although he bought the best quality of belts, the abrasion of the ore wore them out very rapidly, causing continually very large bills for repairs and renewals.

On close examination several interesting points were discovered:

1. It was noticed that the thin layer of rubber which covered the belt resisted the abrasion much longer than did a corresponding thickness of the cotton duck which formed the body of the belt; in fact, the life of the cover represented about one-half the life of the belt, although forming less than one-fifth of the total thickness.

2. Each layer or ply of duck wore out more quickly than the one preceding it, showing that the fibers were cut more easily when under tension, and, of course, the tension on each fiber increased as the number of fibers bearing the tensile strain diminished.

3. The wear was greatest in a line along the center of the belt. Frequently this part would be so quickly destroyed as to cause the belt to split in two longitudinally, though at the same time the portion nearer the edges was almost as good as new.

Noticing these facts, it became obvious that the functions of the cotton duck should be solely to give the belt tensile strength, and that it ought to be so protected by some abrasion-resisting cover that it would not be injured by contact with the material conveyed. It is also evident that this protecting cover ought to be of extra thickness over the center of the belt, in order to stand the harder work forced upon that part. Being engaged then, as now, in rubber manufacture, it was a simple matter to make a belt with a heavy rubber cover on the carrying side and thicker in the center than at the edges.

This reinforced cover renders the resistance to wear equal in all parts of the belt, and although being merely the anticipation of a patch, like the brass toe-cap on the schoolboy's shoe or the two-ply seat in his trousers, it was, like them, deemed patentable.

The ideal conveying-belt would be like the celebrated "one hoss shay," which disintegrated so evenly and completely when its work was done that there was nothing left to repair or regret.

Wishing to ascertain what particular compound of rubber would make the most durable carrying-surface, I made a lot of small samples, each mixed differently, and exposed them to a very powerful sand-blast.

Having at last decided upon the proper compound for the carrying-surface, I applied it to the belts, and I may say that every belt made since that time, which was in 1892, is in good order to-day. In many cases, too, the belts which they replaced had been completely destroyed in three months' time under exactly similar conditions.

There are four principal methods of supporting conveying-belts.

First we will consider the oldest method, in which the belt lies flat upon a straight-faced, horizontal pulley. On account of the liability of the material to roll off the belt, this form is only suitable under certain conditions. The belt cannot be heavily loaded, and the feed must be so regulated that an even amount may be delivered to the belt at all times. If the material is below ¼-inch in size, the speed may be as high as 300 feet per minute. In carrying larger stuff on flat belts the speed must be lower; but the most necessary thing is to keep the belt very tight, that the material may not be jarred off in passing over the idler pulleys. This, of course, increases the strain on the bearings, and from that fact, together with their low efficiency compared with systems to be described later, we may consider flat-running belts as being out of date.

The second method is somewhat like the first, but with the addition of skirt-boards at the sides to increase the capacity of the conveyor.

This method of rigging belt-conveyors is in great vogue among brick-makers and others who handle clay. It will be easily seen that the material must collect between the skirt-boards and the belt, and that, as it hardens, it will cut a strip off each side. The common practice is to start with a wide belt, and move the skirt-boards in as fast as these strips are cut off.

The third method is a slight improvement upon the last, in that a trough is made by raising the sides of the belt instead of using boards as described above. Conical pulleys being used for this purpose.

This method has an obvious fault, owing to its bad design. By reason of the difference between the two diameters, the outer edge of the pulley goes twice as fast as the inner edge. This causes a slip which soon wears out the under surface of the belt. For belts not wider than 14 inches this form is not bad, for, with small belts, the weight on the pulleys is light, and the effect of the slipping is consequently less severe.

The fourth, and best form of belt-support, is composed of three pulleys, one carrying the middle or bottom of the belt, and one on each side with its axis at an angle of about 45°. The shafts of all three pulleys are held in a pair of combination

* Abbreviated from the Transactions of the American Institute of Mining Engineers.

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bearings which can be adjusted to different widths of belts. I never supply any other form of support for belts wider than 14 inches, and when I refer to troughed belts in this paper, it is to be understood that the sides are raised by means of these angle pulleys, one common form of which is shown in fig. 1.

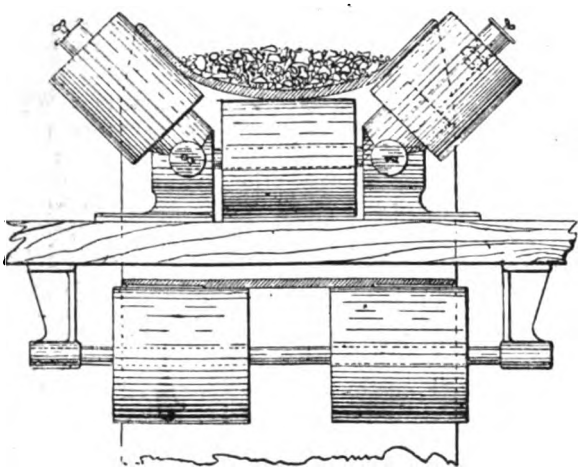

Fig. 1.—Best Method of Supporting Conveying-belts.

There has been no mention hitherto of the means of supporting the empty part of the belt on its return. This is done by a single flat pulley, or with a pair of smaller pulleys with an interval between them, as shown in the lower part of fig. 1.

It is sometimes possible to save money in constructing a long conveyer by combining the first and last methods of belt-support referred to. If the belt were run flat the whole distance, it would need to be so wide that the extra cost of the belt would be about equal to the money saved in using the cheaper flat form of pulley; but by placing a set of troughing pulleys between every fourth and fifth set of flat pulleys, or at such other interval as may be found advisable, the load is so centered on the belt at each of these points that it has no time to overflow before it is again centered between the next pair. In this way the use of a very wide belt is unnecessary, but the conditions are not always favorable to this plan.

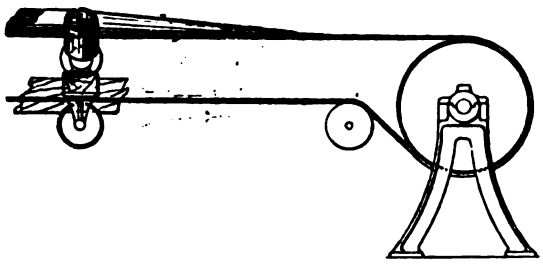

Fig. 2.—Side View, showing the Proper Position for the First Return-idler, in order to gain large arc of contact.

On some conveyers, it is often advisable to have at intervals a pair of idlers, running on a vertical axis, or inclined inward, so as to make a right angle with the edge of the belt. These will serve to keep the belt straight on the pulleys if there is any tendency to run toward one side.

The large pulleys at the end of the belt should be slightly crowned on the face, and the pulleys should not be less than 4 inches wider than the belt. The driving pulley ought never to be less than 30 inches in diameter, and in the case of long wide belts 48 inches is advisable, as it allows the first return pulleys to be so placed as to give the belt a very large arc of contact on the driving pulley. (See fig. 2.)

Whenever it is possible, it is better to have the driving pulley at the delivering end of the belt; but, if it must be at the receiving end, a triple set of pulleys connected by gears can be easily arranged which renders slipping impossible with the longest and heaviest loads. I believe that this scheme was first used by Mr. S. H. Edwards, Superintendent of the Magnetic Iron Ore Co., at Benson Mines, New York.

The proper distance between the sets of idler pulleys is an important factor in the economical running of the belt, as will be referred to later. I believe that the troughing pulleys should be from 4 to 6 feet apart, according to the weight of the load, and that for the return belt there should be pulleys placed under every alternate set of troughing pulleys, which would make the lower pulleys from 8 to 12 feet apart.

To me, one of the most wonderful things in connection with this subject is the exceedingly small amount of power required to move enormous quantities of material. The power required, in one case, to run a conveyer, which carries 1000 tons per day a distance of 180 feet, and elevates it 40 feet while doing so, is all transmitted by a torn and frayed little 5-inch belt, which takes its power from a pulley on the shaft, and transmits it to a pulley alongside the head pulley of the belt. The power is here divided, part of it going over a sprocket-chain to help drive a large dumping-apparatus. Yet the entire amount of power employed for both purposes does not exceed four horse-power.

It is a simple matter to determine the necessary belt width and speed to perform certain duty when the weight per cubic foot of the material is known. If the belt is troughed it is safe to estimate that the load itself will cover one-half of the belt's total width, and that the depth in the center will be one-quarter of its own width.

The widths of belting in most common use are 22, 24, and 26 inches, and the average speed is about 300 feet per minute. I am inclined to favor higher speeds, especially for elevating at an angle, as it requires less power to lift a small sized load

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at a high speed than the same amount of stuff per hour in a larger sized load at a low speed. A good speed for level work is 450 feet per minute; at an angle 650 feet is not at all too fast; and I have seen belts working smoothly at 900 feet per minute and at an angle of 27 degrees. Such speed as this, however, is hard on both the belt and idlers, and I do not recommend it.

Having decided upon the proper width of belting for the duty to be performed the next points to be settled are the proper thicknesses for the belt and for its protecting cover.

The following table shows the suitable number of plies for different widths of conveying belts:—

Belts 20 inches wide and less	should be	4	ply.
„ 22 and 24 wide	„	5	„
„ 26 and 28 „	„	6	„
„ 30 to 36 „	„	8	„

The thickness of the rubber cover should be based upon the character of the stuff to be carried. For hard material weighing over 50 pounds per cubic foot the cover should not be less than $\frac{1}{4}$ inch in thickness. With the patent reinforced cover referred to above, it is possible to have this thickness at the center where it is needed, allowing it to taper off to $\frac{1}{16}$ inch or $\frac{1}{8}$ inch at the sides where the work is lighter. This, of course, makes the cost lower than if the same thickness of cover extended the whole width of the belt. There is now an improved form of this belt which combines the advantages of this thickened cover with stiffened edges which give it such firmness at that part that a mere touch against the steering idlers serves to keep it running true. This stiffening is done by running two or three plies of duck a part of the way in from the edges, giving all the advantages of a heavier belt but at a lower cost. This form will also be patented.

At the point where a belt receives its load it gets as much wear as it meets with in all the rest of its journey. A few points should be borne in mind in connection with this part of the conveyer. The material should not be allowed to drop vertically upon the belt but should instead be so guided by an interposed chute as to strike the belt with as nearly as possible the same speed and, of course, in the same direction as that of the belt itself.

If ore or rock is carried, there is bound to be wear wherever it touches. It is well, therefore, if it has to fall any distance to let its force be broken by striking first against an accumulated pile of itself and then roll off on to a chute, whence it may slide quietly upon the belt and not move until it reaches the end of its journey. See fig. 3, which shows the device in use at the N. J. and Penn. Concentrating Works, Edison, New Jersey.

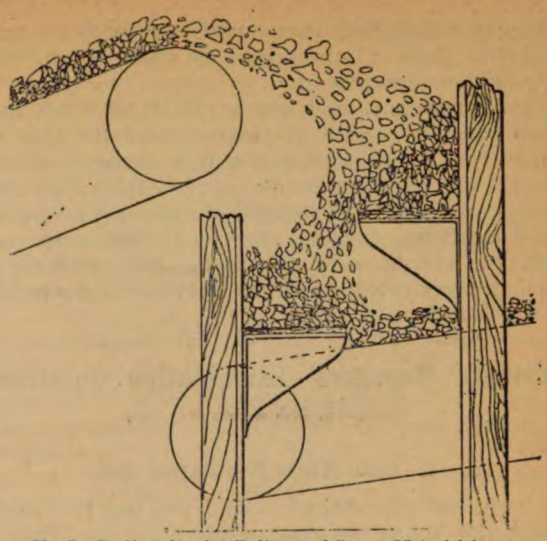

Fig. 3.—Section showing Delivery of Coarse Material from one Belt to another.

There are many ways of joining the ends of carrying-belts, the most common being by the use of metal belt hooks consisting of a set of teeth cast together with a metal back. These have to be destroyed if the belt needs taking up, and a better plan is shown herewith in fig. 4. The thin steel plates are laid upon a strip of thin leather or canvas which covers the opening in the belt and thus prevent leakage. Staples are driven through the holes in the plate and clinched. In breaking the joint the staples are easily cut with a cold chisel but the plates themselves can be used an indefinite number of times. They are the invention of Mr. S. H. Edwards.

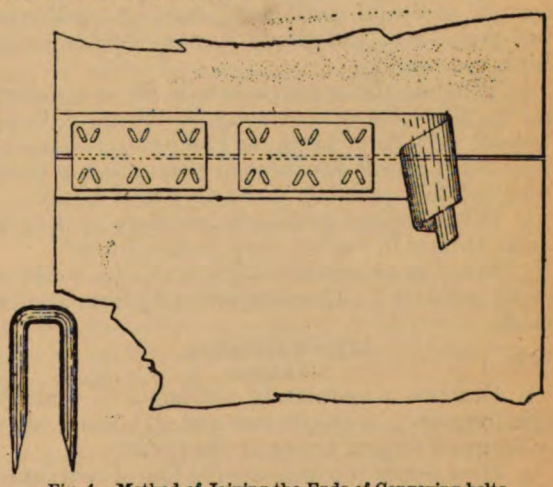

Fig. 4.—Method of Joining the Ends of Conveying-belts.

The simplest method of lubricating the bearings is by means of compression grease cups which are dust proof and very economical. They are screwed into the ends of hollow shafts and a man without stopping can give the handles a turn as he walks

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along the belt, and this only has to be done once a day at most. Grease costing about four cents a pound is generally used.

Belts generally cost less to install than any link belt or other metal conveyer; and the cost of maintenance is so much less that there is simply no comparison between them. In addition to this, they run noiselessly, instead of making a perpetual and deafening racket, and no owner's ears can become oblivious to a banging and crashing of which every vibration means wear and depreciation, as well as loss of power.

Colliery Managers' Examination Questions.

Edinburgh, 24th & 25th May, 1894.

I.—Coal Mines Regulation Act.

(1 Hour.)

1. What precautions would you use to comply with the Act for blasting in dusty and fiery mines?
2. State the regulations as to the employment of persons under 16 underground.
3. What inspections have to be made (*a*) daily, (*b*) weekly? Describe how they should be made.
4. State the regulations regarding (*a*) boilers, (*b*) signalling.
5. State what you would do as a manager if gas was suddenly found during a working shift in a mine where naked lights are in use.

For First-class Candidates only:—

6. What exemptions for single shafts?

II.—Modes of Working.

(1½ Hours.)

1. Sketch and describe a place in a longwall working of any seam of coal in your district; average roof and pavement, showing packwalls, roof props, etc., and giving as many details as you think necessary.
2. What is the average loss of life per annum due to falls of roof and sides in mines of Great Britain; how do you propose to lessen this danger?
3. What recent advances in electricity are likely to be helpful in mining in the very near future?
4. What serious problems are there to face in Great Britain in the not very distant future?
5. What is an average day's work of a collier at a longwall face? Describe minutely from start to finish.

III.—Ventilation.

(2 Hours.)

1. Describe a ventilating appliance to ventilate a pit (non-fiery) with 500 men and 30 horses; show by figures how you arrive at the result.
2. How would you measure the loss of ventilating pressure in turning a sharp corner, say 90°?
3. A pit, 200 fathoms deep, passes 200,000 cubic feet of air per minute, what amount of moisture will this suck out of the workings of the mine, taking the average temperature and saturation of the air in this country?
4. Give some good ventilating appliance for two sinking shafts going through strata giving off fire-damp with the usual heavy blasting going on at the bottom.
5. Stoop-and-room plan to ventilate and criticise.

IV.—Surveying.

(1½ Hours.)

1. How would you determine the variation of the compass, that is, the difference between the magnetic meridian and the line meridian, using the theodolite as an instrument and the sun as an object?
2. (*a*), (*b*), and (*c*) denotes the lengths of the sides of a triangle, how may its area be determined in terms of its sides?
3. A coalfield in shape is a rectangular parallelogram; the sides, 1 mile and a ½ mile respectively, contain 3 workable seams of coal:—

1st seam,	3′ 0″	thick.	Specific gravity, 1·28.
2nd ,,	2′ 9″	,,	,, 1·29.
3rd ,,	2′ 6″	,,	,, 1·30.

Average available amount of coal in the field after making a fair deduction for loss in working, there being no special pillars to be left in.

4. The workings of a colliery extend over the properties of several landlords, explain what precautions you would take to give each landlord his due in the matter of lordship or royalty payments.
5. Explain how you would do the surveying and plan keeping for the workings of an edge field; angle of dip and rise say 60° from the horizontal, it being necessary to reckon out the areas of minerals worked out as well as to keep the workings within the boundary line of the surface.

V.—Winding and Haulage.

(1½ Hours.)

1. What is the average breaking strain of an oak beam 12 inches square, loaded in the centre and fixed at both ends, span being 10 feet?
2. Boiler plates ⅝ in. thick, give tensile strength. What difference would it make if the boiler was single riveted or double riveted for iron and steel respectively?
3. Describe how you would lay the foundation of a square chimney stalk 100 feet high. Give dimensions of outside and inside measurements at top and bottom, thickness of brick, and probable cost for building alone.
4. What are the principal points to be considered in determining the size, form, and position of winding engines?
5. A dook with a varying gradient, 700 yards long, starts half-a-mile from the pit bottom, average dip is 1 in 9, there is an output of 200 tons per day of 8 clear hours; empty hutch weighs 4 cwt. and holds 8 cwt. of coal. Give a description of the method of haulage you would adopt.

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VI.—Arithmetic.

(1 Hour.)

1. 10,000 cubic feet of cutting has to be done in 20 days; 60 men do $\frac{2}{3}$ of the work in 14 days, how many additional men will be required to finish the work in the specified time ?

2. A collier is paid 3s. 10d. per day, and works 5 days a week. He gets an increase of 7% on his wages, how much will the increase amount to in a fortnight ?

3. How many air-courses, 4 feet by 4 feet, will be required to give the same area for air as one 8 feet by 10 feet ? In the last air-course the quantity is 24,000 cubic feet per minute, find velocity in feet per second.

4. A trains runs 1 mile in 48 seconds, what is its speed per hour ? If the driving wheel is 8 feet diameter, how many revolutions will it make per minute ?

5. A circular shaft, 9 feet in diameter and 40 fathoms deep, is filled with water. Find weight of water in tons (1 gallon = 10 lbs.).

North Staffordshire Institute of Mining and Mechanical Engineers.

A meeting of the members of this body was held at the North Stafford Hotel, Stoke-upon-Trent, on Monday, the 11th inst., when Mr. E. B. WAIN presided.

TECHNICAL INSTRUCTION IN MINING.

The PRESIDENT stated that the Technical Instruction Committee of the Staffordshire County Council had offered for competition two mining scholarships, each of the annual value of £30, and tenable at approved colleges or mining schools for two years. Selected candidates would be required to attend examinations, of which notice would be given. The Committee would be prepared to make a maintenance allowance when it could be shown that the circumstances of the candidates warranted this. The council of the institute would meet a sub-committee of the County Council to frame a scheme of technical instruction.

THE ROCKET OIL ENGINE.

Mr. T. H. ARMSTRONG, of Newcastle-on-Tyne, exhibited a Rocket oil engine in motion. He had previously read a paper on oil engines, tracing the lines upon which engineers had worked in obtaining power from oil in internal-combustion engines. He described the different ways of igniting the charge, of obtaining a vapour which would explode when compressed and the use of the timing valve. He emphasised the simplicity and facility for cleaning and repairing the Rocket engine. A valuable patent for eliminating the exhaust from oil engines was also commented upon, this invention having been used successfully in connection with the Rocket oil engine. It was stated that where mines were badly ventilated, or had no return air-course, it was impossible to use an oil engine in a mine without this apparatus.

MODERN COAL TIPPLERS.

Mr. J. J. PREST at a former meeting read a paper on "Some Modern Coal Tipplers," and in the course of his observations, he said, instead of a long array of fixed bar screens, each fitted with its own tippler, the whole output of a large colliery might now be concentrated at one point and passed through a single power-driven tippler at a considerably less cost, and with a great deal more efficiency than was the case under the old order of things. He gave minute particulars regarding the different tipplers.

The PRESIDENT observed that Mr. Prest had described eight types of coal tipplers, three of which had been designed and constructed in North Staffordshire. Those which he had described were driven by power; some were complicated and some were extremely simple. It appeared to him that two of them were absolutely reliable in their working, and both of those were with positive action—The Wood and Burnett and the Heath and Woodworth tipplers—one being a side tippler and the other an end tippler. The advantage in these tipplers was that in them there was a certain positive speed at which the coal might be turned over, and no matter how careless the attendant might be, the coal could only come out at a particular speed. He had used a tippler made by Mr. Silvester with simple friction gear attached, that had tipped a million tons of coal and had cost nothing for repairs. He had no doubt other types of tipplers would be equally economical in their working.

Mr. PREST took exception to the statement that Wood and Burnett's tippler was a positive tippler. It was the same as others; it was driven by a friction clutch, and all the power-driven tipplers were positive in that sense.

After remarks by Mr. WOODWORTH and others, a vote of thanks was accorded to Mr. Prest.

When ordering goods or opening correspondence with an advertiser in the columns of this paper, please mention that you saw the advertisement in "Mining."

All communications appertaining to the sale of the paper, agents, etc., to be made to the Publishers, Messrs. E. Marlborough & Co., 51, Old Bailey, London, E.C.

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Bruntcliffe Colliery.

(YORKSHIRE.)

DESCRIPTION.—This colliery is situated about five miles south-west of Leeds and seven miles south-east of Bradford, and within the Borough of Morley, having its sidings on the G. N. Railway, near Morley Station. The minerals are leased from the Earl of Dartmouth. Mr. Joseph Haigh is the proprietor, and Mr. Matthew Laing the certificated manager of the colliery.

The output of coal, cannel and ironstone, is at present about 500 tons per day of nine hours, but this will soon be greatly increased, as the two new seams to which they have just lately sunk are on the point of being opened out, and the plant at the surface has been designed and modern improvements made to deal with a large output.

At the above colliery four shafts have been sunk, three being used as winding and downcast shafts and one exclusively as an upcast.

The Middleton and upcast shafts were sunk to the Middleton or Silkstone seam in 1850, depth 178 yards, 11 feet diameter. The Cannel pit shaft was sunk in 1856, its diameter being 11 feet, and is 60 yards deep. The Beeston shaft was sunk in 1893, and is 14½ feet diameter, clear, depth 290 yards. The upcast pit, which is only 10 feet diameter, was further sunk from the Middleton to the Beeston seam about the same time.

The following seams are worked at the colliery:—

	Seam.	Thickness. Ft. In.	Depth. Yds.	Quality.
1.	Cannel	2 0	80	Gas-making coal
2.	Middleton Little..	2 8	153	Steam coal
3.	Middleton Main or Silkstone ...	3 8	178	Good house coal
4.	B. Churwell Thin	2 1	283	Splendid gas coal
5.	B. ,, Thick	4 0	290	Splendid gas coal
6.	Black Bed.....	2 0	370	Gas & house coal

WINDING & HAULAGE ENGINES.—The winding engine at the Middleton shaft has two horizontal cylinders 22 inches diameter and 4 feet stroke, drum 11 feet 6 inches diameter, 6 feet wide, with the brake ring in the middle and brake strap all round. The winding ropes are of steel, 1¼ inch diameter, and the safety hooks are Ormerods. The conductors are iron-wire ropes, four to each cage. Two tubs are raised in each cage, one above the other.

The Beeston winding engine has two horizontal cylinders 25 inches diameter and 4 feet stroke, drum 12 feet 6 inches diameter, 7 feet wide, brake ring at each side, brake straps on the under side only. Winding ropes 1¼ inch diameter, fitted with the Ormerod detaching hooks, double-decked cage with two tubs in each deck, four wire conductors to each cage.

The headgear, which is doubtless the finest in the district, is of wood (pitch-pine), and consists of four upright legs and two back stays, 20 inches by 18 inches at the bottom, erected on two brick walls built up to the level of the pit bank, 22 feet above the railway metals; the height from pit bank to centre of pulleys being 47 feet.

The engines at the upcast and Cannel pit are geared to the drums. The upcast engine has one horizontal cylinder 22 inches diameter, 4 feet stroke, geared 1 to 4, drum 7 feet diameter, and a brake on both 1st and 2nd motion shafts. This engine is only used as a second means of outlet for the Beeston and Black Bed seams. The Cannel engine has one horizontal cylinder 15 inches diameter 2 feet 6 inches stroke, geared 1 to 2, drum 5 feet diameter. Two tubs are raised at once, one above the other. The winding ropes are of steel, 1 inch diameter, fitted with Ormerod hooks, and there are four iron-wire conductors to each cage.

All the underground haulage is done by having the engines placed on the surface. The Cannel engines have two cylinders (horizontal) 12 inches diameter, 2 feet stroke, geared to the drums 1 to 3, two drums 5 feet diameter, main-and-tail rope system. The ropes are taken down the shaft in wooden boxes and along the road, which is one mile in length and almost level. Sets of 50 tubs are run each journey, single road; steel rails of the F13 section, about 20 lbs. to the yard, are laid on wood sleepers and nailed or spiked.

Another pair of engines, similar to the above, are placed at the Middleton shaft, and haul for the Middleton Main and Middleton Little seams on the endless rope system. These engines will eventually be used for the Beeston and Black Bed seams, as the Middleton seams are about finished. The engines are geared 1 to 6. On the 2nd motion shaft a C-pulley, 6 feet diameter, is keyed. The endless rope is taken 2½ turns round the pulley and then down the Middleton Main shaft to the vertical shaft in the Middleton Main seam and 2½ turns round another 6 feet C-pulley, which is keyed to the shaft, and back to the surface; a tension pulley is provided near the vertical shaft. On the vertical shaft are placed two pulleys, one 4 feet diameter and the other 6 feet diameter, each having a friction clutch. The 4 feet pulley works with endless rope down a road 800 yards long, and the rope is placed under the tubs, which are attached singly by Fisher clips; speed just over one mile per hour. The other pulley on the shaft (6 feet diameter) works with endless rope for a short distance east of the pit and is then taken up a stone drift, which connects the Middleton Main and Middleton Little seams and from which the Middleton Little seam is won, to a vertical shaft in the Middleton Little seam, on which is placed two friction pulleys with friction clutches. The rope from the Middleton Main to the Middleton Little works under the tubs,

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which are attached singly by means of the Fisher clips; speed, two miles per hour. From the top friction pulley in the vertical shaft in the Middleton Little coal an endless rope is taken west and is on the top of the tubs, the tubs being attached as before. From the lower friction pulley another endless rope is taken south or thereabouts, the rope being under the tubs and attached as before-mentioned; the speed of these two ropes being about two miles per hour. The west road is about 1,100 yards and the south road 1,200 yards long.

BOILERS.—Steam is raised and delivered to the various engines from a range of five boilers working at a pressure of 50 lbs. to the square inch. The whole of the boilers are hand-fired and are fed by a Cameron pump with two inverted cylinders, 8 inches by 8 inches, working two single-acting 6 inch rams and another double-acting 4 inch pump. Two injectors are also in reserve, one a live steam and the other an exhaust steam.

PUMPING.—Very little water is given off in any of the seams, the most being in the Cannel, which is all top water, but the quantity is not great, in fact, after raising this there is not sufficient for the colliery consumption and the town's supply has to be used.

VENTILATION.—Up to 1893 the ventilation was produced by furnace, but now a Capell fan, 12 feet diameter, 5 feet wide, 7 feet single inlet, is the ventilator, 130,000 cubic feet per minute being the quantity exhausted at 180 revolutions of the fan, the engine making 60 revolutions per minute. The fan is driven by a single horizontal engine, 16 inches diameter cylinder, 2½ feet stroke, geared 1 to 3. The driving pulley, 12 feet diameter, has four grooves, the driven pulley 4 feet diameter; cotton ropes are used.

SCREENING.—This is done by means of travelling belts and side shaker screens, recently erected by Messrs. Heenan and Froude, of Birmingham. The tipplers are of the revolving type, and the coal is tipped sideways on to a saddle-shaped piece of iron, separating it into two portions, each portion falling on to a picking band 40 feet in length, 3 feet wide. Boys pick out the dirt and throw it on to a belt in between the two belts which moves in the same direction. The dirt is discharged into a Billy Fairplay and weighed, and the amount sent out by each man is registered and deducted. The coal is discharged on to the side shaker screen, where it is divided into three to five sorts for the different markets.

The engine giving motion to the screens, etc., consists of a pair of horizontal cylinders 5 inches by 10 inches. This description is only for one set, three sets of screens and picking bands are at work.

METHOD OF WORKING.—All the seams are worked on the longwall system. In the Middleton Little coal seam and Cannel coal seam coal-cutters first undercut the coal, fillers following to fill the coal. The coal-cutters are of Gillott and Copley type and are driven by compressed air. The cylinders are 8½ inches diameter and about the same stroke; four coal-cutters are at work. The compressed air plant is at the surface and consists of two steam cylinders 16 inches diameter, 3 feet stroke, and two air cylinders 18 inches diameter, 3 feet stroke, placed tandem form. The compressed air is taken down the upcast pit in 5 inch pipes; 3 inch pipes are laid to gates, and 2 inch pipes to the face. The length of piping laid in the Little coal seam is about 1¾ miles.

The sections of the Beeston seams, or Thurwell Thin and Thick seams are as follows:—

	Yds.	Ft.	Ins.	
Blue bind	4	0	0	
Black shale	0	1	4	Thurwell Thin coal
Coal	0	2	1	
Hard grey rock...	1	2	0	
Blue bind	5	1	3	
Coal	0	1	4	Thurwell Thick coal
Dirt	0	0	10	
Coal	0	0	4	
Dirt	0	1	1	
Coal	0	2	2	

In working the Beeston seams the longwall method will be adopted, but owing to the strata between the two seams being only 7 yards, the top seam will have to be in advance of the lower seam. The method adopted is as follows:—After getting past the shaft pillar a leading bank is put in and a pack put on each side. Gates are put in every 22 yards, which are cut off every 60 yards by a cross-gate turned out of the main gate or horse road. These cross-gates are turned out right and left, the main gates are about 260 yards apart.

The main intake and haulage roads will be in the lower seam, and a cross measure drift will be driven about 530 yards from the pit bottom at right angles to the main road, and another about 800 yards from this; these drifts will cut off the workings in the top seams every 350 yards or thereabouts.

The Black Bed and ironstone is won by a drift from the Beeston bottom seam. This seam lies 80 yards below the Beeston bottom seam, but an 80 yards fault just throws the seam level with the Beeston. This occurs about 400 yards north of the pit; the throw runs east and west.

The Black Bed is being opened out in the same way as the Beeston top seam; one coal-cutting machine is working in it at present.

COAL-WASHING.—A Robinson coal-washer is erected and is capable of dealing with 150 tons of coal in 8 hours. The washed coal is separated into nuts, peas, and duff. The water is used over and over again, being lifted back again by a pulsometer.

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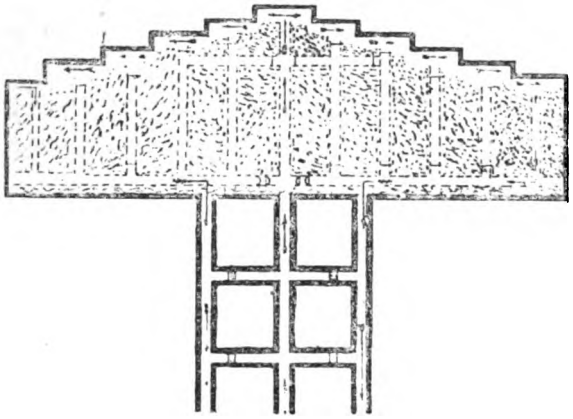
Answers to Competition Questions.

GIVEN IN No. 11, VOL. IV.

LONGWALL WORKING.

(1) Sketch a longwall district for 30 hewers in a shaft. Indicate the course of the ventilation.



Answer.—The sketch shows the method how longwall workings are ventilated, and shows a district for 30 hewers or a larger number if required. The air is carried up the middle gateway or road to the face where it is split, and travels right and left along the face of the working places to the end of the district, and then goes direct to the return. This is a very simple arrangement and needs very few stoppings, doors, and brattices. The air has a short distance to travel, and consequently there is a short length of rubbing surface producing a small amount of friction and requiring little ventilative power, and the gases given off at any point are carried along the face to the returns.

JAMES FINCH.

HOW TO MINIMISE THE RISK OF A COAL DUST EXPLOSION.

(2) What treatment do you consider most practicable for minimising the risk of a coal dust explosion?

Answer.—Various methods have been introduced into mines for minimising the risk of a coal dust explosion, but the one which seems to be most practicable, and which gives every satisfaction, is that of damping the dust with a spray of water, and a thorough cleaning of all the roadways at regular intervals. The best system of watering now adopted is what is known as the "spray system" used in conjunction with compressed air. The water can be brought from the surface or from the column of pipes in the shaft or other convenient place in wrought-iron pipes and conveyed along the side of the roadways in the mine. Branch pipes are fixed at intervals of 50 yards to the main pipes, and standing vertical along the side of the roads, and from these branch pipes another pipe is carried near the centre of the roadway which is perforated at the outer end. The compressed air is brought from the surface in a separate column of pipes and connected to the water pipes, so that when it comes in contact with the water it forces it out through these branch pipes in a fine spray. The velocity of the air current deposits the spray along the roof, sides, and floor of the roadways, and thus the dust is kept saturated with water, and the air is also cooled. The water pipes should be provided with a cock at each junction so that the water may be turned on or off in each district as required. Where a sufficient head of water can be obtained it is not necessary to apply compressed air so long as the pressure is sufficient to produce a fine spray. All the side or bye-roads where no extensive hauling is done should be watered with a tank, of which they are various designs. One of these, which suits the purpose well, is provided with a brush which revolves round. The motion of the brush is derived from the wheels of the tank, and water enters at the centre and flies out at the circumference, thus the roof, floor, and sides of the roadway are kept saturated with water. In addition to this method of watering, I would have all the roads thoroughly cleaned and swept at regular intervals, and the coal dust sent to the surface. In all cases of shot firing I would appoint a competent person to water the place on either side of the shot, within a distance of 20 to 30 yards, and see that the shot was prepared in such a way as to avoid by all means a blown-out shot.

THOMAS HILL.

VENTILATION.

(3) In dividing a mine into different splits of ventilating current, what are the chief points to take into consideration? Give possible example.

Answer.—The chief points which ought to be taken into consideration when dividing or splitting the ventilating current of a mine are:—(1) The splits should commence as near as possible to the downcast shaft and unite again near to the upcast shaft. (2) The splits should be of equal lengths. (3) The number of splits should not be more than will allow the air to travel at a velocity that will be sufficient to clear the mine of gases. (4) The area of the shafts must be considered, and also the area of the roadways.

Let us take for example the first point. It will be quite evident that if the air be not split near to the downcast shaft we shall have a portion of an airway in which the velocity is great owing to the total quantity of air passing in it. The same will take place if the splits do not unite again at the upcast shaft. It is clear that by allowing the air to travel at this high velocity we are doing so at

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the expense of power, because power varies as the cube of the velocity, and if we reduce the length of airway in which this velocity is high we shall gain an additional power. To do this to the greatest extent it will be necessary for each split to have a separate intake and return, commencing from the downcast shaft and uniting again at the upcast shaft.

The second point to be considered is that of having splits of equal lengths. It is a well-known fact that if we have two airways of unequal lengths and passing a certain quantity of air, and the resistance is greater in one than in the other, that with the least resistance will receive the largest portion. So that if the longer airway has to receive an equal share a regulator will have to be placed in the shorter split, *i.e.*, the one with the least resistance. The resistance offered by the regulator plus the resistance in the short split must be equal to the resistance in the longer split to pass equal quantities of air, so we see at once the advantage of having the splits as near as possible of equal length.

Thirdly, every split which is made reduces the velocity of the air to some extent, although the total quantity be increased, so that by increasing the number of splits (which, of course, depends on the length and area of the shafts) the velocity of the air may become too low to keep the workings in a healthy condition.

The area of the shafts and the roadways are important points to be considered when splitting air, because the velocity in the shaft may cause an increased amount of friction, and would require a large proportion of the total pressure to overcome it, which would leave a small proportion to overcome the friction of workings. Sharp curves should be avoided in the airways, and the area should be as uniform as possible, if not, a loss of power is the result. THOMAS HILL.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—James Finch, Green Lane, Hindley Green.

Commended.—M. Forster, 138, Pit Cottages, Throckley, Newburn-on-Tyne, R.S.O.; R. W. Cuthbertson, Hartington House, Staveley, near Chesterfield; T. Hill, Crosby Villa, by Maryport, Cumberland; J. R. Bell, 95, Holbeck, Mosbro', Rotherham; Jas. Davies, Clynderven House, Dyffryn Place, Maesteg, Glamorganshire; R. Matthews, 29, Manor Street, Accrington; J. T. Ward, New Street, Lupton, near Chesterfield; J. E. Keefe, Amble, Northumberland; Wm. Ollerenshaw, 46, Grosvenor Street, Ashton-under-Lyne.

Question 2.—Thos. Hill, Crosby Villa, by Maryport, Cumberland.

Commended.—Thos. Webster, 7, Birchley Road, Billinge, near Wigan; W. E. F. Leadbetter, 3, Front Row, New Bolsover, near Chesterfield; C. McDermott, Bolden Colliery, R.S.O., Durham; Jas. Davies, Clynderven House, Dyffryn Place, Maesteg, Glamorganshire; S. Davies, Barrow Farm, Worsbro', near Barnsley; J. Preston, 22, Chapel Street, Adlington, near Chorley, Lancashire; T. Thomas, 66, Cardiff Road, Rhydfelen, near Pontypridd, Glamorganshire; T. Wilkinson, 25, Brancker Street, Over Hulton, near Bolton; J. E. Keefe, Amble, Northumberland; R. Ankers, 471, St. Helens Road, Daubhill, Bolton; J. Marr, 95, Oakenshaw, Willington, Durham; Harold White, Cornsay Colliery, near Durham; L. Winlow, 18, Fourth Street, Heworth Colliery, R.S.O., Durham; T. Rimmer, 38, Clarence Street, Newton-le-Willows.

Question 3.—Thos. Hill, Crosby Villa, by Maryport, Cumberland.

Commended.—S. Davies, Barrow Farm, Worsbro', near Barnsley; T. Webster, 7, Birchley Road, Billinge, near Wigan; J. Miller, Millside, Bothwell, N.B.; J. Preston, 22, Chapel Street, Adlington, near Chorley; R. Ankers, 471, St. Helens Road, Daubhill, Bolton: C. McDermott, Bolden Colliery, R.S.O., Co. Durham; Harold White, Cornsay Colliery, near Durham; W. Ollerenshaw, 46, Grosvenor Street, Ashton-under-Lyne; J. Davies, Clynderven House, Dyffryn Place, Maesteg, Glamorganshire.

Reports of H.M. Inspectors of Mines, 1895.

THE annual reports of Her Majestys Inspectors of Mines for the South Staffordshire and South Wales districts for the year 1895 have just been issued, from which the following information has been culled:—

SOUTH STAFFORDSHIRE.

This district comprises half of the county of Staffordshire and the whole of the county of Worcester for the purposes of the C.M.R.A., together with the counties of Essex, Norfolk, and Suffolk for the purposes of the M.M.R.A.

Mr. W. Beattie Scott, assisted by Mr. W. H. Pickering, paid 303 visits to mines without complaint or accident having drawn attention to them; 443 mines were visited and 112 accidents investigated.

There were 26,715 employed above and below ground during the year, being over 1,200 less than in the preceding year. The output has consequently been reduced, the output per underground worker being exactly the same as in the previous year, viz., 454·5 tons. The number of mines worked during the year was 349, the output from which was as follows:—Coal, 8,648,693 tons; fireclay, 260,256 tons; ironstone, 42,571 tons; pyrites, 860 tons; cement, 43 tons, giving a total of 8,953,123 tons, against 9,476,334 tons in the previous year.

The total number of fatal accidents was 36, resulting in the loss of 41 lives. The death-rate per 1000 persons employed underground being 1·928, per 1000 above ground ·427, and per 1000 above and below 1·535. This is a favourable record compared with previous years.

SOUTH WALES.

This district comprises nearly the whole of Glamorganshire, part of Breconshire, and the whole of Carmarthenshire and Pembrokeshire. It employs a greater number of persons than any other district and has also the greatest output of coal.

Mr. Robson, assisted by Messrs. F. A. Gray, J. Dyer Lewis, G. F. Adams, and F. N. White, in addition to inspecting mines in consequence of accident or complaint have made a number of casual inspections. With one or two exceptions of small mines, every mine was visited at least once.

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There were 96,634 persons employed above and below ground during the year, which is an increase of 1516 over the previous year. The quantity of mineral raised per underground worker was 308·3 tons, which is a decrease of over 3 tons on that of the previous year. This is owing to the short time worked at many of the steam coal collieries owing to the depression in trade. The total mineral output shows an increase of 45,953 tons on that of the preceding year, whereas the increase in the output of anthracite alone was 211,032 tons, the output of anthracite for the year being 1,761,186 tons. The following is the gross output of the respective minerals for the year:—Coal, 24,355,373 tons; fireclay, 149,378 tons; ironstone, 9,353 tons; shale, ganister, stone, etc., 65,422 tons—total, 24,579,526 tons.

The number of fatal accidents was 173, causing the death of 191 persons. This is a decrease of 249 on the number of lives lost in the previous year, excluding however the number of deaths caused by the Albion explosion in 1894, viz., 290. The year under notice shows an increase of 41 on the number of deaths in the previous year. There were no less than 36 explosions of firedamp reported during the year, 7 of which proved fatal to 10 persons. In addition to the fatal accidents 43 persons were injured by the explosions. The number of explosions reported in the previous year was 29.

Editorial Notes.

The verdict of the jury appointed to inquire into the circumstances attending the Brancepeth Colliery explosion was that the accident was caused by a shot which ignited the coaldust and caused an explosion in the cross-cut way.

* * * *

At the inquest on the Micklefield Colliery explosion it was found that the accident was the result of a gas explosion, that it was purely accidental, and that no blame attached to anyone.

* * * *

In the Chancery Division of the High Court of Justice, on the 21st May, a motion was heard on behalf of the Lancashire Explosives Co., Limited, against the Roburite Explosives Co., Limited. In 1895 the Court of Appeal granted an injunction restraining the defendants from infringing the plaintiffs' patent of 1885. The plaintiffs now alleged that defendants had been manufacturing an explosive called Roburite No. 3 in such a manner as to constitute a breach of the injunction. Mr. Justice Kekewich came to the conclusion that the invention of the defendants was different in substance, process, and result from that of the plaintiffs, that there had been no colourable imitation, and no breach of the injunction.

* * * *

We are in receipt of the following papers from the Transactions of the American Institute of Mining Engineers:—"Standard Physical Tests for the Production of the Blast Furnace and Their Value," by T. D. West; "Some Fuel Problems," by J. D. Weeks; "The Effect of Expansion on Shrinkage and Contraction in Iron Castings," by T. D. West; "The Hydraulic Elevator at the Chestatee Mine, Georgia," by W. R. Crandall; "The Effect of Washing with Water upon the Silver Chloride in Roasted Ore" (Discussion on paper), by Mr. Moore; "The Effect of Additions of Titaniferous to Phosphoric Iron Ores in the Blast Furnace," by A. J. Rossi; "The Embreville Estate, Tennessee," by G. R. Johnson; "The Mobility of Molecules of Cast-iron," by A. E. Outerbridge, Jr.; "The Volatilization of Silver in Chloridizing Roasting," by L. D. Godshall; "Notes on Conveying Belts and Their Use," by Thomas Robins, Jr.; "The Assay by Prospectors of Auriferous Ores and Gravels by means of Amalgamation and the Blow-pipe," by W. H. Merritt, F.G.S., together with the Proceedings of the Annual Meeting, held in February last.

Correspondence.

We will publish a reasonable amount of correspondence per issue, but subject to the following conditions:—

To be written on one side of the paper only.

Envelopes to be marked "Correspondence."

Name and address of sender must accompany such correspondence as a sign of good faith, but the writer may assume a *Nom-de-plume* to be published if he so desires.

Correspondence must not be enclosed with Competition Answers.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

PRIZE COMPETITION.

Sir,—I would suggest that in the place of the Prize Competition you offer a reward for the best answers sent in to the questions of the S. & A. Dept. Mining Examination, that is, to offer a prize of 2/6 to the sender of the best answers to the questions in Section A; the same applies to Sections B and C. That would do for one issue. Then take the Advanced Stage in the following issue in the same way, but with the Honours Stage it would be better to offer a separate award for each answer. Hoping the above will receive your consideration. STUDENT.

(We will consider your suggestion.—ED.)

PLOTTING THE SURVEY.

Sir,—Will John N. Wardell be kind enough to plot the following survey (scale, 3 chains to an inch):—

Line 5		740 00	(600 in 2 & 00 in 3) (00 in 1 & 510 in 4)
Line 4		510 00	(00 in 1 & 00 in 5) (640 in 3)
Line 3		640 00	(00 in 4 & 600 in 2) (740 in 5)
Line 2		600 00	(00 in 3 & 740 in 5) (1110 in 1)
Line 1	N.30°W. 00	1110	660 centre of shaft (00 in 4 & 00 in 5)

We have also four pits, *A B C D*; a line between *A* and *B* connecting them is 200 yards long and lies S60W, *A* and *C* lies S30E, *B* and *C* lies S74E, *B* and *D* lies S30E, *A* and *D* lies S10W. Plot a four-sided figure, *A B C* and *D* being at each corner. Scale, 3 chains to an inch.

There are two posts on the opposite bank of a river, how are we to find their distance apart and their distance from us, assuming that the river runs in a southerly direction and the posts lie in a line S36W?

I find it a difficult task to understand what is meant by the trigonometrical functions of an angle in a right-angled triangle. Some information on this subject would be thankfully received. Hoping I am not intruding too much upon your valuable space and Mr. Wardell's spare moments. JACK.

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'Mining'

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Economy in Steam Raising.

By J. Rigby.

STEAM economy has not as yet received the attention its importance warrants. It is well known that a good fireman can keep up the steam with half the fuel which a bad fireman uses, also without doing the harm to the boiler plates. A bad fireman keeps the whole of his fire in a heap, therefore he damages the plate under which it lays and the rest of the plates are doing no work at all; whereas a good fireman keeps his fire thin and even all over the bars, which gives all the plates an even amount of work to do.

Economical appliances for steam raising are, however, now becoming extensively used. The greatest amount of work is required from a boiler for the least expenditure of fuel. The natural draught is not sufficient to consume all the fuel, therefore a great amount of cinder is made which has not been able to do its work. Forced draught has therefore been introduced to meet these ends.

The following tests were made at the Stanton Iron Works Company's Collieries, Mansfield, and show the considerable amount of difference between forced draught and natural draught. They were made upon three Lancashire boilers, with outside flues, 30 feet by 8 feet, alike in all respects. After the test of the natural draught the bars were taken from that boiler and Woodward's substituted. The boiler being experimented upon was connected to drive a fan engine, 24 ins. in diameter, roped to a Capell fan at the ratio of .7 to 1. The boiler was supplied with water from a tank holding 337 gallons by a Smith injector. The steam pressure, revolutions of fan engine, height of W.G., and ventilation per minute passing through the pit was taken every quarter of an hour. The best rough slack was used of the value of 5s. 6d. per ton.

The first test was made upon a boiler fitted with Meldrum's patent furnace, by Meldrum Bros., of *Manchester*. This patent is well known and requires no explanation. The Empire patent (a German invention) was the next experimented upon. This patent consists of two jets blowing under each furnace, one at the back and the other in front, each jet being a ¼-inch in diameter. The bars are ∧ shaped with small holes drilled through them. The next was a new patent called Woodward's. This patent consists of a small jet blowing *into each* bar. The bars are hollow, and on each *side*, alternately every 3 inches, are holes for the forced draught to exhaust. Forced draught patents generally have the bars close together, this being to prevent small fuel from falling through before it is consumed. In this patent the bars are ⅜-inch apart, therefore the fire procures a good natural draught in addition to the forced draught. Very little fuel falls through unconsumed with good fuel like that used in these tests. In the natural draught Caddy's bars were used, which is undoubtedly a good patent. The results, of course, could not be expected to compare with forced draught. The following are the results of the experiments:—

	Meldrum.	Empire.	Woodward.	Caddy's
Duration of test	6 hours	6 hours	6 hours	6 hours
Fuel consumed	81 cwt.	87 cwt.	81 cwt.	36 cwt.
Water evaporated in gallons	5055	4044	4044	1920
Lbs. of water to 1 lb. of fuel	5·57	4·15	4·45	4·76
Average steam pressure	80 lbs.	45 lbs.	52 lbs.	34 lbs.
Pressure at commencement	92 „	92 „	88 „	88 „
Pressure at finish	76 „	36 „	46 „	28 „
Average revolutions of fan engine	38	32	32	29
Average height of W.G.	2·53 in.	1·65 in.	1·90 in.	1·50 in.
Average ventilation per min. passing through pit in ft.	100285	93000	95000	85989
Average heat of water—Fahr.	190°	185°	185°	185°
Ashes	10 %	9 %	11 %	11 %

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From the above tests it would appear that the English furnace, by Meldrum Bros., gives by far the best results, either judged by the water evaporated, fuel consumed, or work done, as the following synopsis shews:—

	Water evaporated in gallons.	Fuel cwts.	Ventilation in feet per minute.
Meldrum	5055	81	100285
Empire	4044	87	93000
Woodward ...	4044	81	95000
Caddy's	1920	36	85987

This, apart altogether from the fact that the Empire furnace and the Woodward, far exceed it in steam consumption.

Some Fuel Problems.*

By JOSEPH D. WEEKS.

THE world has a vast store of coal. How much, no one knows. But, vast as are these stores, the consumption in certain countries has been so great that nations have affrightedly asked to know how long the supplies would last. In England the question was discussed by such authorities as Sir William Armstrong before the British Association, Mr. Jevons in his work on *The Coal Question*, and in Parliament by John Stuart Mill and Mr. Gladstone. As the result of these discussions, the alarm over the probable exhaustion, in the not distant future, of its coal supplies was so marked that a Royal Commission was organized, who, arguing from several premises, estimated the duration of the supply at various periods, from two hundred and seventy-six years to over twelve hundred years. But the consumption of coal in Great Britain has increased at a rate much in excess of that upon which the lowest estimate of the Royal Commission was based. In 1780, about the time the steam engine was invented, it was some 6,500,000 gross tons a year. It had arisen to 27,000,000 tons in 1816; to 50,875,000 tons in 1850; to 84,042,698 tons in 1860; to 112,875,525 tons in 1870; to 146,969,469 tons in 1880; to 181,614,288 tons in 1890; and to 188,277,525 gross tons (210,870,828 net tons) in 1894. The result of the discussions on the subject of the duration of the coal supply of Great Britain was the conclusion that if the output increases in the same ratio as it has for twenty or thirty years, the coal will be exhausted in a little over a century. These estimates are now regarded as excessive, as it is conceded that there is in each nation a limit to industrial development which, without considering the great economies in the use of fuel, will also limit the expansion of coal production. M. Gruener places this limit for England at 250,000,000 tons, which supposes a mining population of a million miners and a working population of five millions.

* Presidential Address at a Meeting of the American Institute of Mining Engineers.

In this country the production of coal has been increasing in a much greater ratio than in Great Britain. In 1880, the production of coal in the United States is reported at 71,481,570 net tons; in 1889 it had risen to 141,229,513 net tons, nearly double; and in 1893, it was 182,352,774 net tons, an increase of more than 2½ times in thirteen years, doubling about every five years.

Similar increases could be shown for the other great coal-producing countries, as Belgium, Germany, Austria, France, and Russia. The world's demands for heat and power are increasing marvellously, while the world's supply of coal is a definite quantity, and it is an evident proposition that with the exhaustion of its coal not only will the power and influence of a nation decline but even its existence may be imperiled.

The fuel problem, therefore, is not only an industrial one but a political and politico-economical one of the greatest importance.

It is possible, as has been suggested, that other sources of power, and even of heat, such as chemical action and solar energy, especially the latter, may be, and no doubt will be, largely utilized in the future; but these are questions it is not within my purpose to discuss, and the day when these and other sources of power will be largely used will be when the supply of coal is very much reduced and its value very much increased.

As, therefore, we can expect no increase in the amount of the world's supply of coal, the fuel problem is to increase the efficiency of that we have, to make each ton of coal that remains in the hills do a much greater amount of work than it now does.

In a word, the fuel problem is to reduce the waste and increase the efficiency of the coal we possess.

This problem divides itself into three distinct parts—that is, problems connected with:—

1. The mining of coal and its preparation for market.
2. The use of coal.
3. The products of the coal other than heat.

These problems all concern waste.

First, as to the problems relative to mining the coal and preparing it for market.

It is estimated that as the result of the coal-mining of the last fifty years not more than 30 per cent. of the coal remaining in the veins worked has on the average been won and laid down at the point of consumption or use. This loss of 70 per cent. does not of course include the loss due to geological causes, and especially to erosive agencies that have cut so deeply and so wastefully into the coal originally deposited in the coalfields. So great is this geological waste that Prof. Lesley estimates that not over 1 per cent. of the coal originally deposited in the great Pittsburgh bed still remains, and yet he declares this bed, robbed as it has been, to be the most valuable deposit of coal in t

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world. In the later years of this half-century the waste has not been so great; but when all things are considered the estimated loss in mining of 70 per cent. of the coal remaining in the strata is not excessive.

As to the causes of this waste and the methods by which it may be reduced but little remains to be said, at least so far as relates to anthracite coal in this country since the publication of the *Report of the Pennsylvania Commissioners on Waste of Coal Mining*, of which commission Eckley B. Coxe was chairman. Mr. Coxe points out that:—

There are two classes of waste in coal-mining:

1. That which is absolutely necessary and cannot be avoided.

2. That which may be diminished or done away with.

The unavoidable waste is defined to be that portion of the coal that must be left in the mine for various purposes. It does not follow, however, that what is to-day termed unavoidable waste is absolutely unavoidable. It may be, with our present knowledge, but what this term "unavoidable waste," really means, in many cases, is simply that under present conditions, or under the engineering adopted, it is regarded as most economical to leave this coal in the mine. It is left to maintain the workings, the slopes, shafts, gangways, etc., to support the surface, to make the floor and roof, to keep the water from the lower levels and save the expense of pumping; in a word, to keep the mine safe, and in a condition that it can be worked economically. Conditions, appliances, and methods, may so change, beyond question will so change, that what is economical to-day, may be most wasteful to-morrow. The history of mining shows this.

Just what is the loss from this so-called unavoidable waste in mining at the present time is difficult to ascertain. In some instances, it is not 10 per cent.; in others, as high as 50 per cent., or more. This refers to the veins actually worked and to those portions that are worked, and not to those that are in whole or in part regarded as not workable. If this unavoidable waste average 20 per cent. of the amount of coal left, the loss from this source in the United States, in 1893, was 36,470,555 net tons, and on the production of Great Britain, in 1894, it was 42,174,166 net tons. If the waste for 50 years is considered, the amount will be enormous.

This unavoidable waste can be reduced. It is being reduced as the results of the application of engineering skill. When the day comes that the near exhaustion of coal will be a thing of to-morrow, and not of a century, it will be found that a waste that is now called unavoidable will then be termed criminal.

As to the avoidable waste in mining. This is largely due to:

1. Miscalculations as to the amount of coal that must be left for the pillars, etc.

2. The leaving of large amounts of coal unmined in a vein.

3. Imperfect work on the part of the miner.

The loss of coal from miscalculations or bad engineering of the mine is enormous. Pillars may be too large and the coal wasted; or, too small, and the pillars crush and shut off the coal beyond. It is not unusual to leave unmined a part of a vein that is either under or above a slate, and which may not be quite so pure as that mined. The waste from this source is enormous. There are mines in the Pittsburgh region where, with 71½ inches of coal, but 32 inches of clean coal and the bearing-in coal of 4 inches are mined; 36 inches out of 71½ inches are left untouched, a loss of 35½ inches; practically, one-half of the coal is left in the mine, besides the waste in mining. This custom is not at all uncommon. The miner may do his work very unskilfully in bringing down the coal, in loading, and other ways to which I need but refer at this time.

As Mr. Coxe so admirably points out, in the report above referred to, there is, in connection with the preparation of anthracite a large amount of loss. This is not so great with bituminous coal, but there are culm and slack heaps about bituminous as well as at anthracite mines. Mr. Coxe estimates that the amount of coal sent to the culm bank in the anthracite region of Pennsylvania, since mining began, has been 35 per cent. of the total production; or, up to the close of 1892, 315,700,000 tons. At certain collieries, from the year 1820 to 1883, 20 per cent. more coal had gone to the dirt banks than had been marketed, and 50 per cent. to 75 per cent. of total shipments to dirt banks was not unusual.

In view of all these facts, the statement that on the average during the last 50 years not more than 30 per cent. of the coal in the measures mined has reached the place of consumption is not at all surprising.

How can this waste be avoided?

It cannot be entirely avoided, but it can be still further decreased by just the methods by which it has already been largely reduced. Mechanical means, instead of the coal itself, can be used for supporting the roof and surface; gobbing up will often give a much larger percentage of coal; better engineering of the collieries will give better methods and less waste. All of the vein can be mined, even if a portion of it is inferior, and many methods can be greatly improved.

Secondly, as to the problems connected with the use of coal.

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It is estimated that not to exceed 10 per cent. of the possible energy in coal is utilized, indeed 5 per cent. is the amount most frequently named. Some of this loss is unavoidable, and will ever be so until we have solved that greatest of all modern industrial problems, how to obtain energy direct from coal.

But much of this waste is avoidable, and to reduce this avoidable waste is the fuel problem in connection with the use of coal.

(To be continued).

Strikes versus National Prosperity.

THINGS are becoming serious in the coal trade. We have heard of the inadvisability of sending coals to Newcastle before to-day, but now it seems that we are to have coals brought over from Germany, and so near is this new form of competition that the subject was lately honoured by discussion in the House of Commons. There is no doubt that a few years, or even months ago, with our accustomed *laissez faire* we should have considered such an idea as this unworthy of notice and impossible; now we learn that a large German Coal Syndicate are making preparations to supply London and the south of England with coal. They are nothing if not thorough, these German competitors, and they have set about building several big steam tugs, and over a dozen large sea-going lighters, and now they propose lightering the coal direct from the coal pits on the Rhine into London, in much the same way as they have for years been bringing in coke to Rochester and many other places on the south coast. Although as we have said, but a few months ago such an idea would have been deemed impossible and treated with scorn, we have lived to see yet another instance in which the Germans practically demonstrate that they have a way of doing things when they make up their minds, and of doing them quickly. Though we do not anticipate that this shipment of Westphalian coal will at once prove anything very dangerous, it is no doubt the thin end of the wedge, and we may safely say that unless we are careful, before many years are past German coal will be the cheapest, and hold the best market in this land. With the high labour costs which we in England sustain, combined with the heavy tariffs for transportation, we have little chance against the German coal-owners where the wages are not more than half of what we pay here in England, and where the scale for transportation is also so much less.

On the other hand, the natural conditions of the German coalfields are very inferior to those of our own, and for this reason, in spite of the cheap labour, German coal of good quality has steadily maintained a slightly higher price than that of our own at the pit's mouth. Thus in 1891 the price in Germany at the pit's mouth was 8·07s., whereas in Great Britain it was 8·00s. per ton. In 1894 it was 6·68s. in Germany, whilst in England it was 6·06s. per ton. These prices at the pit's mouth show that so far as our immediate production is concerned it is somewhat cheaper than that of Germany, therefore it rests with the labour and the carriage of coal to bring up the cost. We hear that the Germans propose to send their coal in barges down the Rhine, and thence tug them across to the Thames. This, of course, would mean very cheap transport so far as the water transport is concerned, but on the other hand most of the Westphalian colleries are some distance from the river or the sea. Essen, Osnabruck, Dortmund, and many other colliery centres are about 60 miles away from the river and without adequate canal communication. Thus, in a large number of cases railway rates would have also to be added. So far the balance is in our favour, but when we begin to speak of railway rates we are quite out of it, for the Germans have extraordinarily cheap transport tariffs where their export business is concerned. It costs us to bring coal from the great northern coalfields to the Metropolis about 5s. per ton. The supplies from the midland coalfields are carried to the Metropolis for something rather over this figure. Thus we see that by the time we have brought our coal to the English markets and by the time our cousins German have done the same, the prices of both would be about equal.

So far, there would be no particular inducement for German competition in this line. It could not be a paying business according to the rates which we at present know, unless indeed they do as they have done before, and charge higher rates to their home consumers than they do to the English markets. This is the only loophole left for them, and one which has been used on more than one occasion by German manufacturers in English competition. There is no sacrifice which they will not make to open up new fields of labour and operation, and it is quite possible that the far-seeing German looks ahead for the further penetration of our English markets, to those terrible strikes between employers and employed, which for so many months in the year cause our great labour centres to be closed. It is a terrible idea, but in the light of these strikes which are more or less always with us, we must expect, as we undoubtedly shall have, German competition, German labour, and German productions, if they can be given to us at steady, cheap rates, when our own workmen refuse to apply themselves at all. It is unfortunately cutting our own throats, but unless British workmen can be brought to see this, all the talking in the world will not help us out of our difficulties.

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There is a lack of national *esprit de corps* amongst our workers which is most lamentable, and which our German cousins do not suffer from to any great extent. Where the good of the Vaterland is concerned they will put their shoulder to the wheel and try to quit themselves like men, working at a nominal rate to push the cause which they have at heart further afield. The British soldier and sailor will go through anything for the honour of his country, when his blood is stirred and his metal up, but the British workman is not afflicted with over much patriotism, and here it is that his German competitor gains the day. "For the glory of our country" is a phrase really but little understood by that great world which constitutes the *vox populi.—Invention.*

Mining Association of Great Britain.

A MEETING of the executive council of the above association was held at the Westminster Palace Hotel, on Tuesday morning, the 2nd June, Captain Harrison, president, in the chair.

The notice convening the meeting was taken as read. The secretary stated that several members had written regretting their inability to be present.

Coal Mines Regulation Bill.—This Government Bill was further considered, together with the proposed amendments thereto, which had been agreed upon at the last meeting. These and other suggested amendments were discussed at great length prior to the interview with the Home Secretary at noon and were unanimously agreed to.

Sir Francis S. Powell kindly undertook to introduce the deputation to Sir Matthew White Ridley, and it was resolved that the president, Captain Harrison, should state the case for the association, and that Messrs. A. Hood and R. W. Cooper, as representing South Wales and the North of England respectively, should address a few remarks to the Home Secretary on the question as to deductions for small coal.

Steam Engines and Boilers (Persons in Charge) Bill.—A petition against this Bill which was submitted by the law clerk, was adopted and ordered to be signed by the president on behalf of the association.

At 12 o'clock, the gentlemen present at the above meeting waited on the Home Secretary, at Whitehall, with reference to some amendments of the Coal Mines Regulation Bill. The deputation was introduced by Sir F. S. Powell, Bart., M.P. The case in support of the desired amendments of the association was stated by the president, Captain Harrison. After a short discussion in which Mr. A. Hood (South Wales), and Mr. R. W. Cooper (North of England), took part, the Home Secretary promised a careful consideration of the points placed before him.

Colliery Managers' Examination Questions.

West of Scotland District (Glasgow), November, 1895.

FIRST-CLASS CANDIDATES.

Three hours allowed for this paper.

The value attached to each question is shown in brackets.

Surveying and Drawing.

Candidates not to answer more than *four* questions.

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1. Describe fully how you would make an undergroun survey—

(*a*) With magnetic needle loose.
(*b*) With magnetic needle locked, or by vernier.
(*c*) The various modes of plotting the above that you are acquainted with.
(*d*) Show how you mark your bearings in your book. (10)

2. Plot the following bearings: N.E., 80°—205 links; N.E., 6°—157 links; N.W., 45°—96 links; N.W., 5°—103 links; N.W., 89°—87 links; S.E., 5°—103 links; S.W., 80°—205 links; S.E., 45°—96 links; S.E., 89°—87 links; S.W., 6°—157 links. Then calculate the area in acres, roods, poles, and yards. (12)

3. Show in figures how to reduce the following measurements, taken on inclined planes, to horizontal lengths, viz., 347 links at 1 in 4; 570 at 1 in 5; 434 at 1 in 6; and 540 at 1 in 7. (12)

4. What is your experience of changes in the direction of the magnetic meridian; and how would you find what it ought to be at any time? And also how would you correct one on a plan made 20 years prior to date? (10)

5. Sketch neatly in side and end elevations what you consider the best way of forming an air-crossing in a stoop and room working.

The seam of coal is lying at an inclination of 1 in 5, and is 4½ feet thick, with a soft blaes roof 9 feet thick. The rooms are 12 feet wide. State all sizes, and the materials you would use in construction. (10)

Arithmetic.

Candidates may answer *all* the questions, but not more than 40 marks to be allowed.

1. What is the square root of 95,355,225? and what is the square of 635? (8)

2. What is the capacity of a coal wagon whose inside dimensions are 11 feet 9 inches long by 6 feet 4 inches wide, by 4 feet 6 inches deep, and how many tons would it contain when filled level with the top, counting 42 cubic feet to a ton? (10)

3. A mine 26 fathoms long cost 110*l.* 11*s.*; 9 fathoms 2 feet of it cost 5*l.* 13*s.* per fathom. How much per fathom was the cost of the remainder? (8)

4. A collier working five days per week and putting out 3 tons per day, earns 18*s.* 9*d.* per week, how much is he paid per ton, and what will have to be added to his rate per ton to enable him to earn 25*s.* per week? (10)

5. If 600,000 cubic feet of air pass through an air-course 10 feet wide and 6 feet high in an hour, what is velocity o current in feet per minute? (8)

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Three hours allowed for this Paper.

Modes of Working Coal and other Minerals.

Candidates to answer all the *five* questions, and must obtain at least 30 marks for them.

1. State under what conditions of roof and pavement generally, you would prefer to work a seam of coal, by long-wall, or by stoop and room.

In a seam of coal 4 feet thick, dip 1 in 8, with roof and pavement equally suitable for either mode, compare them as to the following details:—

(*a*) As to cost for wages of all kinds.
(*b*) As to cost for timber.
(*c*) As to roundness of coal.
(*d*) As to safety to the workmen from (1) falls of roof and sides; (2) from explosions; (3) for facility in ventilating. (15)

2. There are two seams of coal with roof and strata between, as follows:—

	Ft.	Ins.
Sandstone	4	6
Fakey blaes	3	0
Coal	3	6
Fireclay	1	0
Fakey sandstone	1	9
Blaes	3	10
Sandstone	4	6
Blaes, very soft	3	0
Coal	4	3
Fireclay	1	3

What mode of working would you adopt for each, and which would you work first?

In which of the modes would the collier receive the greatest benefit from the "weight" being on the coal?

Which of the seams would be the cheaper to work, supposing 250 tons a day coming from each?

Give full reasons for your preference, with details. (15)

3. There is a seam of coal, 4½ feet thick, at 96 fathoms deep, with 6 to 7 feet of black blaes for a roof (with rock above these), which fall freely in the rooms shortly after being worked, requiring a large amount of redding, and splitting or slicing off the sides of the pillars ultimately, in order to get them out.

What size of pillars or blocks of coal, and what width of rooms would you form, so as to reduce the above evils as much as possible?

State your opinion in regard to withdrawing the props at once, and allowing the blaes to fall in the rooms; and if wood, iron, or steel props would be most preferable for such a method? (15)

4. Sketch and describe how you would lay out a colliery of 600 acres of a rectangular shape, by the long-wall system, having a seam of coal 5 feet thick, dip 1 in 6.

There are to be two pits 60 feet apart near the centre of the field, and coal is to be drawn at each at the rate of 450 tons per day, both from the rise and the dip of the workings.

Show how you would keep the rise water from getting to the dip workings, and all the necessary trap doors and air-crossings. Also how you would land the hutches from the dook, so as not interfere with the hutches on the level roads. (15)

5. What size of pillars and width of rooms would you advise to be formed in a seam of coal 5 feet thick, with a hard roof and a soft pavement, so that the greatest amount of coal would ultimately be got, at

(*a*) 60 fathoms deep,
(*b*) 100 „ „
(*c*) 180 „ „

And what percentage of coal would be in the pillars in each case?

What rule have you for determining the area of the pillars you propose? (15)

Three hours allowed for this Paper.

Sinking, Fitting, and Pumping.

Candidates need not answer more than *four* out of the *five* questions.

A pit is sunk to a depth of 110 fathoms. The output of coal to be 600 tons daily from a seam 4 feet thick, lying at 1 in 15. The quantity of water to be pumped is as follows:—

First feeder 100 gallons at 16 fathoms from the surface.
Second „ 200 „ 50 „ „ „
Third „ 100 „ 85 „ „ „
Fourth „ 80 „ 110 „ „ „
In all 480 gallons per minute.

The workings to be ventilated by fan. Mechanical haulage is to be used throughout the workings.

1. Show, by sketch, and figures on plan and section, the form of the pit, and how you will divide and secure permanently these divisions. (8)

2. Write and describe how you would commence sinking operations, and carry on the work continuously. What appliances you would adopt, what tools and tackling you would use, and also your travelling set of pumps, with their sizes and attachments. (10)

3. As the metals are very loose and broken for 4 fathoms immediately above the first feeder, explain, by sketch and figures in detail, how you would overcome the difficulty by making the shaft quite dry and secure at this part. (10)

4. Show, by sketch and figures, what arrangement and connexions you would make for driving the dook, seeing 40 gallons of water per minute follow down on the face, and how you would utilise the pumping engines for this work. (8)

5. Show, by sketch and description, the style of pumping engine and boilers you would adopt, the pumps working 20 hours per day. (12)

Winding and Haulage.

The following questions have reference to the pit in sinking fitting, and pumping questions.

Candidates need not answer more than *four* out of the *five* questions.

1. Show, by sketch and figures, the description and size of winding engines, giving diameter of cylinder, and length of stroke. The drum to be 15 feet diameter, and the boiler pressure 60 lbs. per square inch, working eight hours per day. (12)

2. Should the winding engine be required at any time for lifting water from the bottom of the pit, show, by sketch and figures, what appliances you would adopt for doing so, and what weight of water you would propose bringing up at one time. (10)

3. Show, by sketch on the accompanying plan No. 1, how you will arrange for working haulage by mechanical means, where you place the cousies, tail-rope, or endless rope systems; also show how and where you connect the tightening carriage. (10)

4. The haulage engine being placed on the surface, show, by sketch, how you arrange the shafting, drums, and clutches for conveniently working the different systems; also give a sketch and description of each of the different methods for connecting the hutches with the rope or chain. (10)

5. Sketch and describe the form and size of hutches, the section and weight of rail, the size and kind of sleeper, and the gauge you would adopt for a colliery, having a dip of 1 in 15, and what sizes you would adopt for one having a dip of 1 in 4, giving your reasons therefor. (8)

(To be continued.)

The ventilation plans given with these questions will be published next issue.

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Report of Her Majesty's Inspector of Mines, 1895.

WEST OF SCOTLAND DISTRICT.

THE district embraces the counties of Argyle, Ayr, Bute, Dumbarton, Dumfries, Kirkcudbright, Renfrew, Wigton, and the western portions of Lanark and Stirling. At present no mines are being worked under the C.M.R.A. in the counties of Bute, Kirkcudbright, and Wigton.

Persons employed.—The total number of persons employed in and about mines was 39,657. A comparison with the previous year shows that there is an increase of 568 persons, of whom 187 were employed below ground and 381 above ground. The comparatively greater increase in the number employed on the surface is accounted for by the extending application of coal cleaning and washing arrangements. The employment of female labour at the picking tables is being more largely introduced, which is indicated by the number of females employed having advanced from 240 in 1894 to 394 last year. Six years ago only 77 females were employed. Employment of this nature is more healthy than the work of many factory workers, the work is not too severe, and when carried on under proper supervision cannot, in the inspector's opinion, have any reasonable objections brought against it.

Output of Mineral.—During the year the total quantity of mineral raised amounted to 13,620,367 tons, being the largest output ever recorded in the district.

The following table gives the quantities of the various minerals raised, together with similar figures for the preceding year :—

Mineral.	Tons, 1895.	Tons, 1894.	Increase, 1895.
Coal	12,559,843	9,264,170	3,295,673
Fireclay	369,978	276,464	93,514
Ironstone	627,675	506,607	121,068
Oil shale	23,651	15,402	8,249
Other minerals	39,220	36,492	2,728
Total	13,620,367	10,099,135	3,521,232

The disastrous strike of three months duration in the year 1894 accounts for the greater part of the marked increase in the production of coal. The number of tons of mineral raised per person employed below ground was 417 tons, and per person employed above and below ground 343 tons, which is larger than that of any year since 1889, which indicates that on the whole the miners have had good employment and have taken advantage of it.

Accidents.—Notices were received of 309 separate accidents, which is an increase of 46 as compared with the preceding year. The fatal accidents, including one which happened in 1894, but did not terminate fatally during that year, numbered 56 as against 49 during the previous year, and resulted in the death of 78 persons as against 49 during 1894. This is the largest death roll recorded for 40 years, and is due principally to two accidents by which 20 lives were lost. Seeing, however, that as for the last seven years the mines in the parishes of Blantyre, Bothwell, Dalziel, and East Kilbride, in Lanarkshire, have been added to the district, and as no fewer than 22 of the lives lost happened in these mines, the year as regards the number of deaths is really not so unfavourable as some of those which have preceded it. During the year there was one death by accident out of every 508 persons employed. The non-fatal accidents numbered 253, and by them 297 persons were injured, being an increase during the year of 39 accidents and 64 persons injured.

The death rate per 1,000 persons below ground was 2·144, above ground 1·140, and per 1,000 above and below 1·967. The total number of explosions reported was 49, and of these two proved fatal to 14 persons, while by the 47 non-fatal explosions 66 persons were injured. The previous year there were 5 fatal explosions with the loss of five lives, while the non-fatal explosions numbered 21 and resulted in the injury of 34 persons. Of the 49 explosions 46 were ignited by naked lights, and of the remaining 3, although safety lamps were used, it is probable that two were caused by naked lights illegally exposed.

The fatal accidents by falls numbered 22, and resulted in the death of 23 persons, as compared with 19 accidents and 19 deaths the previous year. The non-fatal accidents by falls numbered 104, being four more than during the preceding year. As in former years a large proportion of these accidents might have been prevented by the simple precaution of setting props closer to the working face, and by setting "gibs" to the working face in time, while it was being undercut.

Inspection Duties.—Mr. J. M. Ronaldson has been assisted by Mr. T. H. Mottram and Mr. A. Pearson in seeing that the statutory requirements were observed. Nearly all the mines at work throughout the year received at least one underground inspection, more or less complete, and many were visited more frequently.

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Report of Her Majestys' Inspectors of Explosives, 1895.

THE twentieth annual report under the Explosives Act has now been issued. In the year 1895 there were 134 factories and 382 licensed magazines compared with 55 factories and 199 magazines when the Act came into force twenty years ago. The number of persons employed during the year 1895 was over 10,000. The number of deaths from accidents or by explosions in manufacture was 10, a very satisfactory record.

The amount of nitro-glycerine compounds imported was as follows :—

	Lbs.
Blasting Gelatine	15,650
Carbonite	223,000
Dynamite	56,300
Gelatine Dynamite	493,920
Matagnite Gelatine	91,500
Total.....	880,070

This is an increase of 340,268 lbs. on the amount imported in 1894, but it does not reach the average of former years when a greater foreign trade was carried on. The number of detonators imported during the year was 6,981,000 as against 9,765,400 in the previous year. There are six factories in this country in which these indispensable adjuncts to the use of explosives can be made.

The following have been added to the list of authorised explosives during 1895 :—Dahmenite A, electronite (Nos. 1 & 2), emeral powder, Faversham powder, Pigon's military smokeless powder, Pigon's sporting smokeless powder, roburite (No. 3), Rosslyn smokeless powder (No. 1), Rosslyn blastite, low-tension electric fuses (No. 5 definition), and low-tension electric detonator fuses for ditto.

The following are among the new explosives examined during the year by Dr. Duprè :—

Britainite.—Preliminary examination made and reported on last year, now fully tested and recommended for licensing, provided that the chlorate of potassium present did not exceed 1·3 % of the finished explosive.

Dahmenite A.—This is a variety of britainite in which the chlorate of potassium is replaced by dichromate of potassium; favourably reported on, provided the dichromate did not amount to more than 2·5 % of the finished explosive.

Electronite.—In 1894, an explosive, called electronite, had been submitted and unfavourably reported on. A second variety, to be called electronite No. 1, submitted later in the year, was, however, favourably reported on. During the year 1895 a licence for an explosive of a totally different character, but to be called electronite No. 2, was asked for, and as it was simply an ordinary nitrate mixture it was not considered necessary to subject it to any chemical examination in regard to its stability.

Faversham Powder.—This consists of ammonium nitrate mixed with several dinitro derivatives of hydrocarbons and some alkaline chlorides. The explosive passed through all tests and was favourably reported on.

Roburite No. 3.—This is said to possess the advantages claimed for the presence of an organic chlorine compound, viz., that of rendering the explosive safe in fiery mines without the use of chlorinated dinitro benzol employed for the purpose in original roburite. It passed successfully through all tests and was favourably reported on.

Electric Detonator.—The mixture for these detonators which among other ingredients contained chlorate of potassium and precipitated sulphide of antimony was reported on to the effect that if the inventor would restrict himself to the use of native sulphide of antimony in place of the precipitated sulphide, the detonators might be licensed.

Moon's Low-Tension Electric Detonator.—This was favourably reported on with the above restriction as to the use of native sulphide of antimony only.

Rosslyn Blastite.—This is simply Rosslyn smokeless powder No. 1, but of such a character as to be suitable for blasting, and no objection was raised against it.

Competition Questions.

An award of 5s. will be made to the sender of the best set of answers to the questions given below, and 2s. 6d. to the sender of the second best set. Answers to be as brief as possible, and sketches must be made when necessary.

Envelopes to be marked "COMPETITION," and to reach us before June 26th, 1896.

(1) What tools are required for boring shot holes (*a*) by jumping and (*b*) by single-handed drilling ?

(2) Sketch and describe two methods of securing a large level with masonry.

(3) Explain the construction and uses of the capstan and shear legs of a pumping engine shaft.

(4) Compare the weights and strengths of a round wire rope 3½ inches circumference, and a flat one 2¾ inches by ½ inch, both of best plough steel quality.

(5) What are the best methods of preparing timber for underground use ?

Any information respecting Advertisements in this paper will be given on application to the "THE MANAGER," Advertisement Department, "Mining" Office, *Clarence Works*, Wigan.

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Federated Institution of Mining Engineers.

A GENERAL MEETING of the members of this institution was held in London last week. The members assembled at the rooms of the Institution of Civil Engineers on Thursday, under the presidency of Mr. G. A. Mitchell (Glasgow).

The PRESIDENT in opening the proceedings delivered an address in which he made special reference to mining science and arrangements at the present time compared with those of fifty years ago. Among the many circumstances which had influenced the improvements effected were (1) Government legislation accompanied with the appointment of inspectors of mines, (2) the spread of education and knowledge among those engaged in mining, and (3) the establishment of mining societies with the facilities afforded thereby for the publication of information and for the discussion of matters affecting mining in its different branches.

Detailing some of the important points in which there had been a marked change for the better over the whole country, the President said there was nothing more important about a colliery than the ventilation of the workings, and he dealt at some length with the different methods which had been adopted, referring to the fact that as far back as 1556, Agricola in his book, *De Re Metallica*, gave descriptions of several forms of fans and mechanical ventilators, many of them crude in form but differing little in principle from the various forms of fans, etc., of the present day. The first ventilator introduced to any great extent was that of Struvè, for which a patent was taken out in 1846, and consisted of two large chambers moving up and down in water contained in a tank, so as to form a double pump. To the improvements in ventilation in conjunction with the improvement in the construction of safety lamps was largely due the decrease in the fatal accidents from explosions. The death-rate per thousand persons due to explosions of firedamp was 1·280 in 1851-55 and 0·281 in 1891-94. A great improvement in the health of miners was also traceable to improved ventilation and mining; formerly one of the most unhealthy of occupations was now one of the most healthy.

There had been great progress in the various details of conveyance of coal from the working-face to the surface, and perhaps the development of the winding arrangements for shafts was as interesting as any change dealt with in the history of mining appliances. There had been a gradual evolution, and the improvements have been largely called forth by the necessity for greater facilities to cope with increasing outputs.

The various stages in the evolution from an early time may be given as follows:—Hand windlass or gin. Horse gin. Gin worked by natural water-power. Gin worked by water-power pumped up for the purpose by a steam-engine. Winding-drum coupled direct to steam-engine. Automatic arrangement for slowing the baskets when passing each other in the shaft, to prevent collisions, rendered necessary by the increased speed of winding. Guides as a more effective arrangement to prevent such collisions. Cages to convey the hutches to the surface. Improved winding-engines.

Probably the invention which as much as any other had assisted in the improvement of winding facilities was that of the wire rope.

The difference between the systems of underground workings now and those of fifty years ago was perhaps not so great as might have been anticipated. Almost all forms of working now in operation were common in the past in various districts, but there was now, perhaps, less rooted prejudice in favour of any particular system, and more effort devoted to choose the system best suited for special conditions, and there was very much less coal lost than in the past.

In comparing the position of mining now with that of forty or fifty years ago it was necessary to avoid the error of imagining that perfection had been reached and that great improvements were unlikely in the future. The history of mining told of a constant gradual progress, and as it had been in the past they must believe it would be in the future.

Our successors in the next generation will doubtless look upon many of our arrangements as clumsy and antiquated. We can more readily believe this if we consider the extraordinary activity in scientific discovery during the last few years. We have been startled by the discovery of a new constituent in atmospheric air, the analysis of which was considered to be so well known. That chemists should in the past have failed to discover argon, this new gas, appears almost incredible. We have been even more startled by what is perhaps the greatest discovery of modern times, that of the Rontgen, or X rays, as they have been called, a discovery which is likely to prove of immense direct value to medical science, and which may lead to an extension of our general scientific knowledge. In the article in the *Quarterly Review* on the subject, the writer says, "Lord Kelvin anticipates unhesitatingly the establishment of a general theory which shall include light (old and new), old and new knowledge of electricity, and the whole of electromagnetism; and the approaching disclosure can be foretold of a more profound correlation of physical forces that can at present be distinctly apprehended." With the history of such discoveries before us we can well believe that there is no finality in mining science, and we can safely predict improvements in machinery and appliances, and we can believe that in the future there may be not only further consolidation of knowledge but important new inventions and discoveries.

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The President then referred to the great strides made during recent years by electricity and to its increasing applicability to mining operations; familiarity with electrical transmission of power would probably lead to many changes in the future and among others to the more extensive use of coal-cutting machines, by which many thin seams should become workable that had in the past been neglected.

After referring to the conditions of trade, the disadvantages under which this country laboured as compared with Germany, Belgium, and other countries, in the matter of railway rates, the frequent disputes between masters and workmen, &c., the President concluded his address by a short review of other subjects on which important contributions had been made to the Institution, more especially gold mining and the treatment of ores.

On the motion of Prof. HULL, seconded by Mr. DOUGLAS, a very cordial vote of thanks was awarded to the President for his address.

Professor HALDANE, Lecturer in Physiology at the University of Oxford, read an account of some investigations which he had made on the nature and sources of the suffocative gas met with in wells, together with further observations on the blackdamp of coal mines, which was discussed at some length.

Mr. J. MCLAREN (Leeds) read a paper on the subject of "Road Locomotives," in which he fully detailed their principles and construction.

A discussion followed the reading of the paper, in which particular attention was drawn to the restrictions imposed by Government and Local Authorities on the use of road locomotives.

A paper on "The Gobert Freezing Process of Shaft Sinking" was submitted by the inventor, Mr. A. GOBERT. He stated that in 1891 he introduced into France the method of sinking shafts by freezing, a method which was then in its infancy. The operations were effected by means of an uncongealable liquid, but his subsequent lengthy experience has induced him to dispense with this liquid, and to initiate the process of direct freezing.

The old process of freezing water-bearing strata comprises the sinking through these of a certain number of tubes known as freezing-tubes, and the circulation through these tubes of an uncongealable liquid cooled down to a temperature below o degs. Cent. In this method the pressure within the tubes is invariably greater than the pressure outside them, and this brings about leakage of the uncongealable liquid, if there be any cracks in the tubes, or if the joints which unite these be not perfectly water-tight. The liquid leaking out into the surrounding strata communicates to them its uncongealable properties, and if the strata are already frozen it dissolves the ice, forming an uncongealable mixture. In order to obviate this difficulty he tried to hit upon a cold-transmitter whose pressure should be lower than that of the water outside the tubes, and anhydrous gaseous ammonia appears to fulfil this desideratum. When anhydrous liquid ammonia is evaporated under various pressures the following temperatures are obtained:

—35° C. (—31° F.)	corresponding to a pressure of	0·90 atmospheres.
—32° C. (—25° F.)	"	atmospheric pressure.
—30° C. (—22° F.)	"	a pressure of 1·15 atmospheres.
—25° C. (—13° F.)	"	" 1·46
—20° C. (— 4° F.)	"	" 1·84

With ammonia vapour, therefore, we may always reckon upon very low pressures. If the tubes were not water-tight, instead of the ammonia leaking out, the water from the surrounding strata would force its way in; and so soon as the tube would be mantled with a coating of ice, the water would cease to come in.

If simply a cold gas were introduced into the freezing-tubes the process of cooling down would be a very slow one. In order to avoid the fall of the liquid to the bottom of the freezing-tube, which would happen if a straight vertical pipe were used as the injector, and to vaporize as much of it as possible in a given unit of time, the injector is made of the wavy or serpentine form in one plane or of the helicoidal form. His plan is to put the injector down near to the bottom of the freezing-tube. The liquid, whose entrance into the injector is carefully regulated, falls slowly in a thin stream within this serpentine or helicoidal tube, and meets on its way a series of small orifices placed at various intervals along its valley-bed. By these orifices the liquid escapes into the freezing-tube. The heat required for vaporizing the liquid is supplied by the surrounding soil or strata. It passes through the walls of the freezing-tubes, and through the wall of frozen strata which soon surround the freezing-tube. The injector is closed at its lower end. As a general rule, the process of freezing can be so regulated as to freeze, first of all, the upper measures. The mass of ice will then spread from top to bottom. The whole power of the engine will at first be applied to the freezing of the rocks near the surface. Thanks to this arrangement, sinking can be started much sooner than in the case of the uncongealable liquid process. Simultaneously with the sinking operations, fresh strata will successively freeze and allow of continuous sinking.

Mr. BRYAN DONKIN submitted a contribution on "Powdered Coal for Firing Steam Boilers."

Mr. RAVENSHAW submitted a paper on "The Precautions Necessary in the Use of Electricity in Coal Mines," an abbreviated account of which will be given in next issue.

Other subjects discussed were:—"The Southern Limit of the Nottinghamshire Coalfield," by Mr. G. E. Coke; "The Indian Goldfields," by Mr. A. G. Charleton; "The Witwatersrand Goldfields," by Prof. L. de Launay; "Mechanical Roasting of Ores," by Mr. Horace F. Brown: "Lake Superior Mining Ore Region, with Special Reference to the Masabi Range," by Mr. Horace V. Winchell.

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Answers to Competition Questions.

GIVEN IN No. 12, VOL. IV.

DANGER WHEN PUMPING A FIERY COLLIERY.

(1) What danger is to be apprehended when a fiery colliery, having workings to the rise and which has been drowned out, is being cleared of water by pumping?

Answer.—When the water in the shaft has been lowered to a certain level at which its pressure, being less than the pressure of the confined gas, is unable to counterbalance the pressure of the gas, the gas begins to bubble up through the water in the shaft. Now when the gas begins to pass up the water is set into violent agitation, which seems immediately to greatly reduce its power to counterbalance the pressure of the gas. The result is that an occurrence takes place, which has often been observed, and is described as the water-blast. The gas instead of coming off gradually in a small stream of bubbles, comes away furiously and throws the water up in the shaft with great violence to a considerable height. This constitutes a danger to any workmen who may happen to be in the shaft and it may also wreck the shaft fittings. Naked lights should not be allowed in the shaft nor near the top.

An example of the above occurred in the No. 2 Snab Pit, Kinniel Colliery, Linlithgow, and caused the loss of two lives, a full account of which is given in the report of H.M. Inspector of Mines, J. B. Atkinson, East Scotland (1890).

The explosion appears to have been caused by the gas existing at a high pressure in the abandoned workings of the old seam that had been standing for a number of years. As the head of water in the shaft was lessened by the chesting, the tension of the gas overcame the pressure due to the head of water and it escaped suddenly into the shaft and ascending through the water ignited at the naked lights used by the workmen, causing two explosions and resulting in the loss of two lives.

C. M. DARMONT.

DESCRIPTION OF A BANKING ARRANGEMENT.

(2) Describe with sketch what you deem to be the best, and most economical working, banking arrangements for dealing with 1200 tons per day from one shaft. Say depth of shaft is 600 yards, capacity of trams 10 cwt., and there are two seams being worked from the one mouthing.

Award doubled for this question.

Answer.—SHAFT.—The shaft (s, in sketch) to be divided by wood brattice, each compartment to be used for winding from respective seams. Winding to be performed by two double horizontal direct-acting engines, calculated to do half as much work again as required, to allow for friction of engine, etc.

CAGES.—The cages, four in number to be double-decked, holding two tubs in each deck. The decks to be changed separately on one landing, which is a considerable saving in wages, as only one staff of men is required.

HEAPSTEAD OR STAGE.—To be supported by cast-iron columns, 24 feet above level of rail and placed from 10 to 15 feet apart. The columns to have flanges on them for the purpose of receiving cross-timbers, and to rest on a solid foundation of stone, having no less than 2½ feet clear space between them and the side of the wagons under the screens, so as to avoid accidents. The staging to carry the screens, weighing-machines and cabins, which are to be fixed in such a position as not to obstruct the view from engine-house to shaft.

TIPPLERS.—Two in number, to be of the side-tipping kind, which performs its duties better than any other kind of tippler, affords facility and speed in working, a regular discharge of coal with a minimum breakage, and facilitates manœuvring of tubs.

SCREENING PLANT.—The tubs to run from the cage to the weigh-bridge and then to the tippler (T). The coal passes from the tipped tub by an iron shoot on to a shaking-screen (SS), the essential part of which consists of a thin steel plate with circular holes, through which small coals pass. Shaking is produced by a double eccentric (EC), which gives the screen a back and forward motion, the throw being about 6 or 9 inches. The screen is set at an inclination of 1 to 5, and is flattened out to 1 in 7 at the delivery end, making 100 vibrations per minute. The large round coal is delivered on to a picking-belt (PB) 90 feet long and 4 feet 6 inches wide, placed 30 inches above the platform on which boys pick out the worthless material. The belt travels at the rate of 50 feet per minute, and moves on rollers turning on an octagonal drum at each end, the breadth of one side being equal to the breadth of the plate; the shaft of the drum (SD) is a sheave, 2 feet diameter. Both belts are put into motion by shafting, spur-gearing, and belting, worked by one engine as shown on plan. The discharge end of the belt is movable, and when allowing high wagons or trucks to come under the screen the belt is raised by means of pulley blocks, and having got the truck in, the belt is again lowered, thus there is a minimum of breakage. The picking-belts can be worked independently of each other by putting them in or out of gear, as required, by turning a wheel, which works a clutch.

The small coal which passes through the perforations when shaking is carried by an endless travelling canvas belt, turning on wood rollers, to a hopper (H). To guard against a possible coal-

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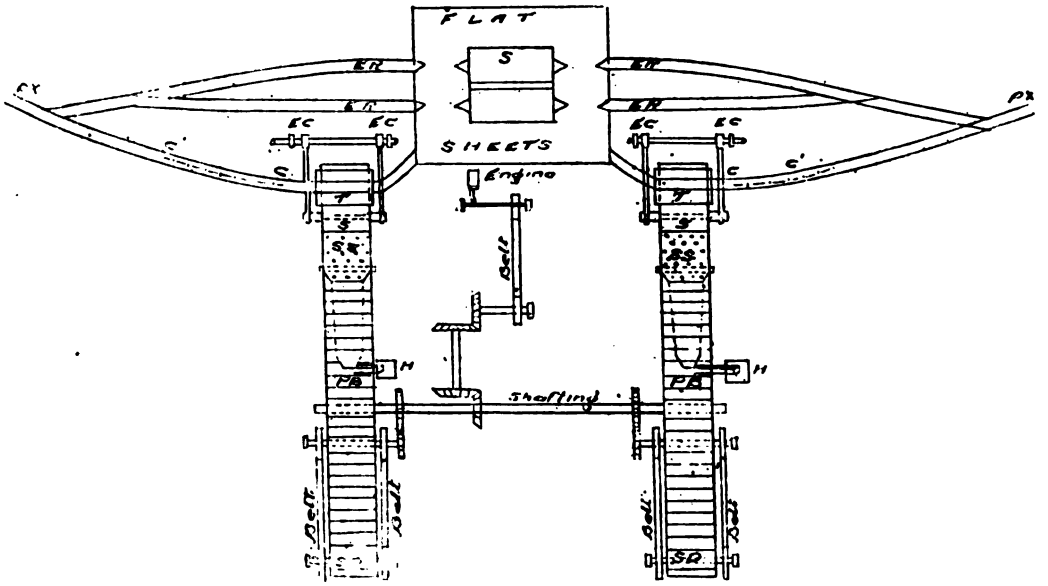

dust explosion about this hopper, a steam jet is constantly exhausting into it, thus damping the dust. The coal is elevated from the hopper by means of an endless chain, with buckets attached, to a separate building, which contains two jigger screens, 8 feet by 4 feet, and one canvas travelling belt, 30 feet by 2 feet 6 inches. The coal is emptied from the buckets on to an iron shoot and then to an upper jigger, made of strong wire meshes, the apertures being small enough to allow only duff coal to pass through, which is conveyed down a spout to a wagon. The rest of the coal is delivered on to another jigger, which allows peas to pass through. Nuts are then delivered on to a canvas belt and the dirt is picked out by boys. By these arrangements four wagons on parallel lines of rails can be loaded at once—round coal, nuts, peas, and duff. The backward and forward motion of the jigger screens is produced by double eccentrics. All belts are worked from one engine by shafting, belting, and spur-gearing. All the coals which pass from the buckets and miss the iron shoot are caught by a trap or spout and conveyed back to the hopper.

Circulation of Tubs.—The token or check number of the getter is taken from the empty tub which passes on to a slow-moving endless creeper chain (c c^1), which is worked from the main shaft. At distances of about 6 feet there are vertical fingers or projecting pieces in the chain. These are rigidly fixed and are sufficiently long to engage on the axles of the tubs, thus conveying them up a short incline rising 1 in 8. After reaching the summit (c^1) they run clear of the chain down an easy incline to the points P X. Here the inclination changes to a rise of 1 in 4, but the momentum acquired by the tub in gravitating down the incline c^1 is sufficient to carry it beyond the spring and part of the way up the incline (P X). The momentum of the tub being expended, however, it returns back, but the spring points at P being set against it, it returns into the empty roads (E R) to be placed in readiness on an inclined plane, 1 in 40, where they are retained in position until the cage arrives at the bank.

The railways under and about the screens to have an inclination of $\frac{3}{8}$ inch per yard, so as to enable the empty wagons to move quietly under the screens by gravity and the loaded wagons to run after being started.

It is an advantage to have a duplicate belt, to be used when one of the others is out of order.

R. W. Hall.

Awards.

For Answers to Competition Questions.

Question 1.—C. M. Darmont, Boldon Colliery, Co. Durham.

Commended.—R. Petch, Station House, Aldin Grange, County Durham; Wm. Ollerenshaw, 46, Grosvenor Street, Ashton-under-Lyne; G. Tweddell, 9, Lloyd Street, Lemington-on-Tyne; J. Emmerson, Harbottle Yard, Oldgate, Morpeth; C. Burne, South Hetton Colliery, near Sunderland; S. Davies, Barrow Farm, Worsbro', near Barnsley.

Question 2.—R. W. Hall, 1, Railway Street, Murton Colliery, Sunderland, Durham.

Commended.—Jas. Laverick, Butterknowle, *via* Darlington, County Durham; S. Wane, 206, Pall Mall, Chorley, Lancashire.

Correspondence unavoidably held over.

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Some Fuel Problems.*

BY JOSEPH D. WEEKS.

Continued from last issue.

WHAT has been done in reducing this waste in the last 100 years is simply astonishing, and what is of especial interest is that many of the improvements and processes that have been introduced into the arts within this time have been the results of attempts to diminish this waste of fuel.

Fuel in the arts has at least a three-fold use.

1. As a simple heat agent.
2. As an agent of chemical changes.
3. As a source of power or better energy.

We have no complete estimate of the consumption of coal for various purposes in the United States, but the Royal Coal Commission, in 1871, and Mr. Price Williams, in 1889, made very careful estimates of the distribution of coal consumption for Great Britain. I had hoped to have obtained an approximate estimate of the consumption of coal for various purposes in the United States, but so far have failed.

The estimate of the Royal Commission is as follows:—

* Presidential Address at a Meeting of the American Institute of Mining Engineers.

CONSUMPTION OF COAL FOR DIFFERENT PURPOSES IN GREAT BRITAIN—COAL COMMISSION ESTIMATE, 1871—TONS OF 2240 POUNDS.

Uses.	Tons.
Iron	32,446,606
Power amd general manufacturing	25,327,213
Domestic	18,481,527
Gas and Water	7,811,980
Mining and collieries	7,225,423
Steam	3,277,562
Railroads	2,027,500
Smelting other than iron	859,231
Miscellaneous	195,045
	97,652,087

Percentages for Various Uses.

	Per cent.
Metals and mines	44
Domestic, including gas and water	26
General manufacturing	25
Locomotion by land and sea	5

CONSUMPTION OF COAL FOR DIFFERENT PURPOSES IN GREAT BRITAIN—WILLIAMS' ESTIMATE, 1889.

	Per cent.
Production of steam power, including collieries	30·30
Manufacture of pig-iron and metallurgy	17·26
Navigation	8·66
Railways, including fixed engines	3·98
Waterworks and miscellaneous	1·40
Domestic use	17·44
Export	15·09
	100·00

It is impossible at this time to distribute this consumption even approximately into the three uses, heating, chemical, and power, but it will be seen readily that by far the larger consumption is for power and in iron manufacture. It would seem from an inspection of these two estimates that from 60 to 70 per cent. of the coal consumed is for power, and for iron and steel manufacture.

What economies have been wrought in these industries in the past 100 or 150 years?

In engines since the days of the Newcomen engine the duty of 94 pounds of coal has increased from 7,450,000 foot-pounds to 140,000,000 foot-pounds, the highest duty of Mr. Leavitt's pumping engine at Louisville, and the pounds of coal per indicated horse-power decreased from 26·6 pounds to 1·33 pounds, an increase in duty of 20 times, and a reduction in coal, of course, of $\frac{1}{20}$.

The following table shows what has been done in detail:—

Duty of Cornish Engines.

	Duty in foot-pounds per bushel (94 pounds) of coal.	Pounds of coal per I.H.P. (estimated).
Newcomen	7,000,000	26·6
Smeaton	10,000,000	18·6
Watt, 1800	20,000,000	9·3
Lean's report, 1815	52,300,000	3·6
Lean's report, 1827	67,000,000	2·8
Lean's report, 1834	98,000,000	1·9
Lean's report, 1840	107,000,000	1·7

Highest duty of Mr. Leavitt's pumping engine at Louisville 140,000,000 per 100 pounds of Pocahontas coal. Pounds of coal per indicated horse-power, 1·33.

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As to the reduction of waste in iron and steel manufacture. To show what has been accomplished I need only mention Neilson's hot-blast, the Bessemer or pneumatic process, the Siemen's regenerator.

One example of the reduction in the use of coal in iron manufacture must suffice. In 1828 Neilson invented the hot-blast, which Mushet said "ranks with the invention of cotton spinning." At the Clyde Iron Works, in 1829, for a six months' run the average coal consumption per ton of pig with cold-blast was 8 tons, 1 cwt., 1 qr.,; for six months in 1830 at the same furnace with the same blowing engine the consumption with hot-blast was 2 tons, 5 cwt., 1 qr. To-day we are making pig-iron with a ton of coke, or 1½ tons of coal to a ton of pig.

This indicates what has been done in the arts in reducing fuel consumption.

But our modern practice has not reached the limits of economy. If we get but 10 per cent. of the available energy out of our coal there must be a vast field for the exercise of engineering skill in reducing this enormous waste of 90 per cent. Sir William Armstrong states that without carrying economy to extreme limits all the effects now realized from the use of coal could be obtained by an expenditure of half the quantity.

In what direction are we to seek for the answers to the problems connected with the use of coal? I can only briefly indicate them. They are:—

1. A more perfect combustion; that is, from the same amount of fuel more heat units must be developed.

2. Improved appliances for saving this heat and transmuting it into energy. Not only must these increased heat units do more work, but each individual heat unit must directly develop more energy.

3. Recuperation of so-called exhausted energy; that is, the heat must continue at work until the actual limit of exhaustion has been reached.

The use of gases instead of solid fuel is an example of the first direction in which we are to look for the answers to the problems connected with the use of coal. The improvements in the steam-engine noted above are examples of the second class, and the Siemen's regenerator and compound engines of the third.

Thirdly. The saving of fuel products other than heat.

It has been learned that there is locked up in coal a marvellous series of products. I need but name the brilliant coal tar dyes, those contributions of untold value to the healing art as phenacetin and antipyrine, many of our modern perfumes and essences, and saccharine, sweeter than cane sugar.

While the discovery and character of these products are the fairy tales of science and while the products themselves are of untold value to mankind, there are fuel products other than heat and power and other than these coal tar products that in amount and value far exceed these dyes and medicines and perfumes. The chief of these are the tars themselves from which are derived the light and heavy oils, the creosotes and benzoles, the ammonia from which we get that most valuable of all fertilizers, sulphate of ammonia, upon which the exhausted fields of our country must depend for their renewal of power. From the nitrogen of this fuel we may also obtain that most poisonous of drugs and yet that valuable agent in gold extraction, cyanide of potassium.

The amount of these products contained in every ton of coal and the consequent amount that we are every year throwing into the air as waste, aggregates an amount almost beyond belief. In every ton of coal coked in the United States it is fair to assume that from any of the by-product coke ovens there can be produced at least 3 per cent. of tar worth ⅛ of a cent per pound; 1 per cent. of sulphate of ammonia worth 3 cents a pound; ½ of 1 per cent. of benzole worth 2 cents a pound; and 1 pound cyanide of potassium worth 50 cents per pound. As in 1893, 14,916,147 tons of coal were coked in the United States, the possible production and value at present prices of these products would have been as follows:—

Materials.	Amount (pounds).	Value (dollars.)
Tar	596,645,880 ...	1,988,820
Sulphate of ammonia ...	298,322,940 ...	8,949,688
Benzole	149,161,470 ...	2,983,229
Cyanide of potassium ...	14,916,147 ...	7,458,073
		21,379,810

The above products, however, are only those from the 15,000,000 of tons of coal coked in one year. What about the value of the by-products of the 113,000,000 tons of coal not coked? How many tons of tar and ammonia and benzole and cyanide could be saved from this amount of coal? The amount of ammonia would be something enormous, though the tar and benzole, if the coal was properly burned into gas before it was applied to heating purposes as it should be, would not be so great as when the coal is coked. The Mond circular producer, which I saw at work a year ago in England on Yorkshire coal, gives 48 kilos (105 pounds) of sulphate of ammonia per ton of coal charged, and 80 to 90 pounds was the regular yield, and all this vast amount of sulphate of ammonia, for which our worn-out land all over the United States is crying, is being lost.

Let us recapitulate.

Of the coal still remaining in the seams worked, not more than 30 per cent. on the average in the last 50 years has been won, that is, 70 per cent. has been lost.

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The percentage of the possible energy of coal utilized to-day does not exceed 10 per cent. if it reaches 5 per cent. That is, but 10 per cent. of the 30 per cent. of the coal won in our veins, or but 3 per cent. of the possible energy imprisoned in the coal in our hills is ever released for useful work. The value of this lost energy must every year, in the United States alone, reach hundreds of millions of dollars.

A low estimate of the value of by-products per ton of coal burned would be fifty cents. This would be 64,000,000 dollars on the coal mined in 1893. For an age that prates so loudly of its economics, this is a sorry showing.

Is there not in this fuel question a problem that demands most earnest work from our engineers, and in which there is for the miner and manufacturer untold wealth ?

(Concluded.)

North of England Institute of Mining and Mechanical Engineers.

A GENERAL MEETING of the members was held in the Lecture Theatre of the Institute, on Saturday, June 13th, 1896, Mr. T. W. Benson (in the unavoidable absence of the president, Mr. Thomas Douglas) in the chair.

After the conclusion of the usual routine business, the chairman intimated that the Council had decided to take the present opportunity of showing their thanks, in a substantial way, to Mr. A. C. Kayll, the engineer to the "Flameless" Explosives Committee of the Institute, for the valuable services he had rendered them, and called upon Mr. A. L. Steavenson to make the presentation, which took the form of a splendid gold watch and chain, and a cheque for £94 7s. 0d.

After a few remarks from Mr. J. L. Hedley (H.M. Inspector of Mines), Mr. Kayll responded, and after thanking them for their handsome present, commented on the work the Explosives Committee had had to perform during the several years of its labours.

Discussion upon the "Report of the proceedings of the Explosives Committee."

Mr. W. N. ATKINSON (H.M. Inspector of Mines) said the thanks of all interested in coal mining were due to the members of the committee for the great amount of time and trouble they had devoted to the experiments, and for the care with which the results were tabulated in their report.

They had proved that there was no such thing as a "flameless" explosive at present in the market; but they had also demonstrated that there were several explosives much safer than gunpowder, dynamite, &c., which until recently were the only ones available. The Committee had very properly insisted in their report that none of the explosives tested afforded complete immunity from danger of explosion in firedamp or coaldust, and that it was necessary to take the same precautions in their use as with gunpowder; but he considered that they might have emphasized the greatly increased safety of several of the explosives tested as compared with gunpowder, as in the experiments only two ignitions of coaldust were recorded from 324 shots. If the same number of charges of gunpowder had been used under the same conditions, ignitions, he considered, would have occurred in nearly every case.

No doubt if what he might call "working charges" had been used in the experiments of the Committee, the results would not have been so favourable to explosives tested; but even when "working charges" had been used, as in the case of Mr. Winkhaus' experiments in Germany, it had been shown that were several explosives whose degree of safety was greatly in excess of that of gunpowder or any of the old explosives—still they could not properly be called "flameless."

He (Mr. Atkinson) thought it appeared probable that the amount of the charge used was an important element in experiments with explosives, and he suggested that if more were known of the subject, greater safety might be arrived at by limiting the amount of any explosive to be fired in one shot hole.

Referring to the discussions which had already taken place upon the report of the committee, he thought the remarks as to the influence of the length of stemming might give rise to wrong impressions. In practice, the stemming was used to prevent blown-out shots, whereas in the experiments of the committee, the stemming was not used for any such object, and, in fact, did not prevent the shots being blown out. A blown-out shot was one of the most dangerous results of blasting in coal mines, and the proper amount of stemming to be used was a matter of the greatest importance. The 8th conclusion of the committee, he considered, read almost like a recommendation to use a short length of stemming, so that any shot which had missed fire might be fired by the insertion of another cartridge in front. This was a risky thing to do, and the amount of stemming which could then be placed in front of the second cartridge would be very small indeed, and the risk of a blown-out shot would be greatly increased. He considered any such method of dealing with misfires very dangerous, especially in fiery and dusty mines.

Referring to the lengths of flames recorded as having been produced by the various explosives, he considered their accuracy as very doubtful; and he regretted that more certain methods of observation had not been adopted.

The CHAIRMAN invited discussion, but suggested that it might be desirable to adjourn the further consideration of the report until the meeting of the members to be held in Lancashire, on July 14th and 15th.

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Colliery Managers' Examination Questions.

West of Scotland District (Glasgow), November, 1895.

FIRST-CLASS CANDIDATES.—(Continued).

Three hours allowed for this Paper.

Mines Regulation Act, 1887.

Candidates are not to answer more than *four* questions.

1. What is the definition of a mine given in the Act? (5)

2. State the provisions of the Act with regard to the fencing of

(1) Places not in use;
(2) Shafts.

State the special rules in your district with regard to mid workings in shafts. (5)

3. State shortly the provisions of the Act with regard to the use of explosives in mines. (5)

4. State the provisions of the Act with regard to plans. (5)

5. State the conditions under which a mine may be worked with a single shaft. (5)

Ventilation.

Candidates need not answer more than *five* questions, in which Nos. 1 and 2, with plans, must be included, and they should obtain at least 30 marks under this head.

1. Plan No. 1 shows stoop and room workings in a 6 feet seam. Show on the plan how you would ventilate them so as to allow naked lights in the solid places, with safety lamps in the stooping. Give the quantity of air in each current, and show the brattices, screens, stoppings, doors, regulators, and air crossings. Show which roads would be used as drawing roads, and criticise the plan so far as ventilation is concerned. (20)

2. Plan No. 2 shows longwall workings in a 4 feet seam which gives off a considerable quantity of firedamp. Show on the plan how you would ventilate them, giving the quantity of air in each current, and showing the screens, stoppings, air-crossings, doors, and regulators. Criticise the plan so far as ventilation is concerned. (20)

3. What quantity of air would a Guibal fan, 20 feet in diameter and 5 feet broad, draw through an airway 10 feet wide, 6 feet high, and 3,000 yards long, when it was running 40 revolutions per minute?

(Co-efficient of friction per square foot of rubbing surface = ·0217 lb. of pressure per square foot of an area of section for a velocity of 1,000 feet per minute.)

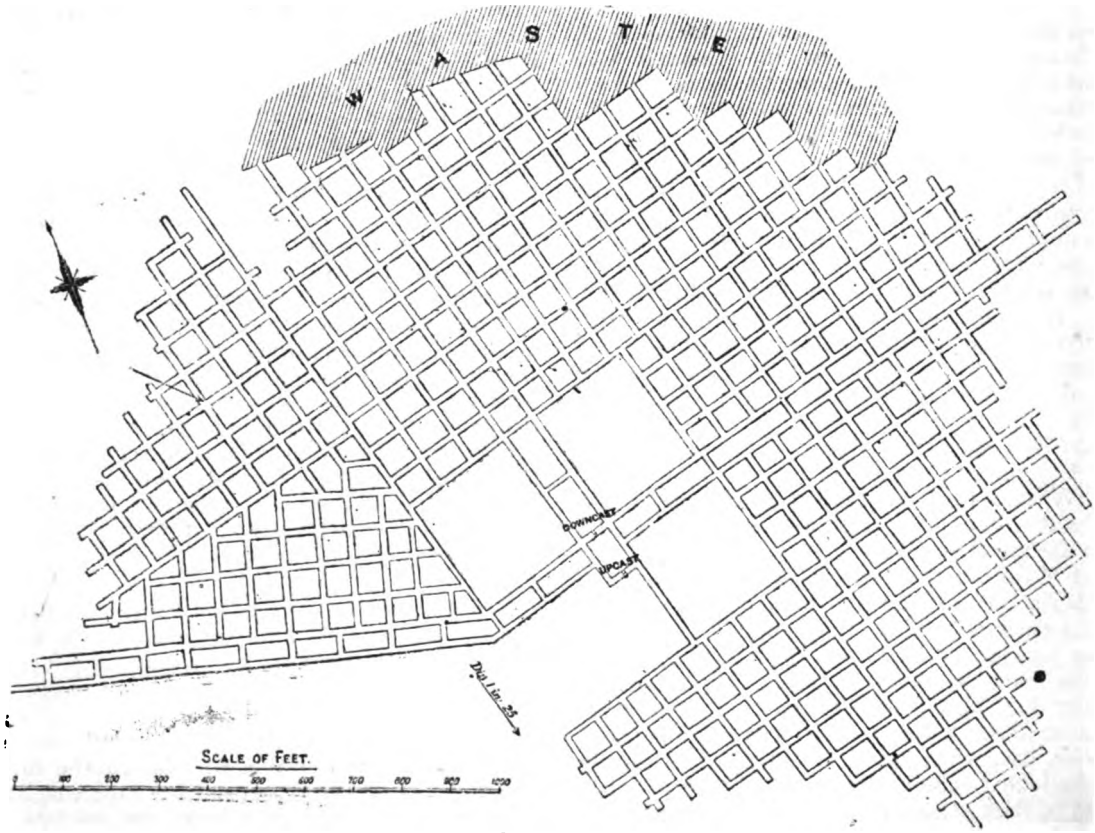
State approximately the difference of the co-efficient of friction for three airways of similar dimensions—

A. Lined with crowns and props;
B. With the roof and sides unlined;
C. With a brick arch and sidewalls. (16)

4. Describe, with sketches, the arrangements you would adopt to ventilate a rectangular pit 24 feet long and 8 feet wide, while it was being sunk 140 fathoms. State the quantity of air you would have in the bottom. (14)

5. What effect will a sudden fall in the barometer cause on the ventilation of a mine? (12)

6. What practical experience have you had in the ventilation of collieries? (16)



Plan No. 1.

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SECOND-CLASS CANDIDATES.

Three hours allowed for this Paper.

Surveying and Drawing.

Candidates to answer at least *three* of these questions.

1. Sketch neatly sections of the various seams of mineral you have worked, including 4 to 6 feet of the roof and pavement. Give full details of the hard and soft portions, with any ribs of stone, and also their thicknesses; whether worked by longwall, or stoop and room, and give the weight produced per day as a man's work. (5)

2. Describe what benefits, present and future, would arise from having the levels of the main roads put on the plans of collieries. What datum would you use for such levels, and give your reason therefor? (10)

3. Describe how you would set about levelling a dook road having a gradient of 1 in 2. Also show how you would level on agradient of 1 in 25. State your reasons for altering the mode of doing the work. (5)

4. Find the area of a field, 300 links square, in acres and decimals.

What weight of coal is there under it, in a seam 4 feet thick. 30 cubic feet of coal = a ton. (10)

Arithmetic.

1. What is the square root of 274576? And the square of 843? (5)

2. A seam of coal, 5 feet thick, is being worked with rooms 14 feet wide, at the rate of 1*s.* 4*d.* per ton; it is desired to begin working it by measurement. What should be paid per fathom to be equal to the above tonnage rate (30 cubic feet being = a ton). (10)

3. What extra diameter will a drum require to be formed, to wind from a depth of 120 fathoms that is presently winding on the same shaft with a drum 10 feet in diameter from a depth of 100 fathoms? (6)

4. An airway, 10 feet by 4½ feet, has a speed of 5 feet per second. How many cubic feet of air is passing per minute? An airway, 10 feet by 4½ feet, has 13,500 cubic feet per minute passing through it, what is the speed per second? (5)

Three hours allowed for this Paper.

Modes of working Coal and other Minerals.

Candidates to answer *three* of these questions.

1. Two seams of coal in the following section are to be worked:—

	Ft.	In.
Sandstone	10	6
Fakes bedded...	3	6
Soft blaes	6	6
Coal, hard	3	6
Hard ribs of blaes adhering to coal on under side	0	3½
Coal, soft	1	6
Hard fireclay...	0	10
Fakey sandstone	1	6
Blaes, soft	3	6
Fakey beds	3	9
Coal, soft	3	3
Soft fireclay	2	6

What mode of working would you adopt for each, and which would you work first? (6)

2. In long-wall workings, what are the advantages of having the "weight" on the face? and how would you get and keep it there? Sketch, in cross-section, the wall face and the method of "spragging" the coal after being holed, and describe the necessity for, and benefit arising from doing so. (5)

3. Sketch and describe how you would take out coal pillars 40 yards square with average roof, and what are the chief points to aim at and what to avoid, in order that as little little coal and propwood may be lost as possible.

Make a sketch plan of a lift of pillaring, showing position of rails and props, how far apart, what size and kind of timber you would prefer, and describe the best system of withdrawing them, in a seam 5 feet thick, with a soft blaes roof 3 feet thick, and at a depth of 100 fathoms.

4. Give a short description of the various modes of working coal as practiced in this country, explaining fully the circumstances under which each system is most suitable. (5)

Three hours allowed for this Paper.

Sinking, Fitting, and Pumping.

You are not to answer more than *three* questions.

1. A 50 fathoms pit, having an output of 200 tons of coal per day, and 12 inch pumps is about to be sunk. Write out a concise journal how you would proceed and carry on the work continuously. (4)

2. What size and description of an engine or engines may be required? (3)

3. What number, size, and description of boilers will be the most suitable, giving your reasons therefor? (3)

4. Describe the style of indicators, gauges, and safety valves; also lubricators for cylinder, and journals you would recommend. (3)

Winding and Haulage.

You are not to answer more than *three* questions.

1. What do you consider the best form of cages and guides, and how would you secure them in the pit? (3)

2. What description of rope will you use in winding, and state wherein hemp may be preferred to iron or steel? (3)

3. Give a short description of the endless chain rope system of haulage. (3)

4. Give a neat sketch of all your surface arrangements and fittings. (3)

Three hours allowed for this Paper.

PART I.

1.—MINES REGULATION ACT, 1887.

Candidates need not answer more than *four* questions.

NOTE.—The writing of candidates will be judged from this paper.

1. State the provisions of the Act with regard to—
   (*a*) Signalling in shafts and planes;
   (*b*) Chains;
   (*c*) Enginemen. (5)

2. State, shortly, the provisions of the Act with regard to the employment of women and boys. (5)

3. State the provisions of the Act with regard to manholes. Would you have them all on one side of the road or partly on one side and partly on the other? Give reasons for your answer. (5)

4. State, shortly, the provisions of the Act with regard to the use of explosives in mines. (5)

5. State the conditions under which a mine may be worked with a single shaft. (5)

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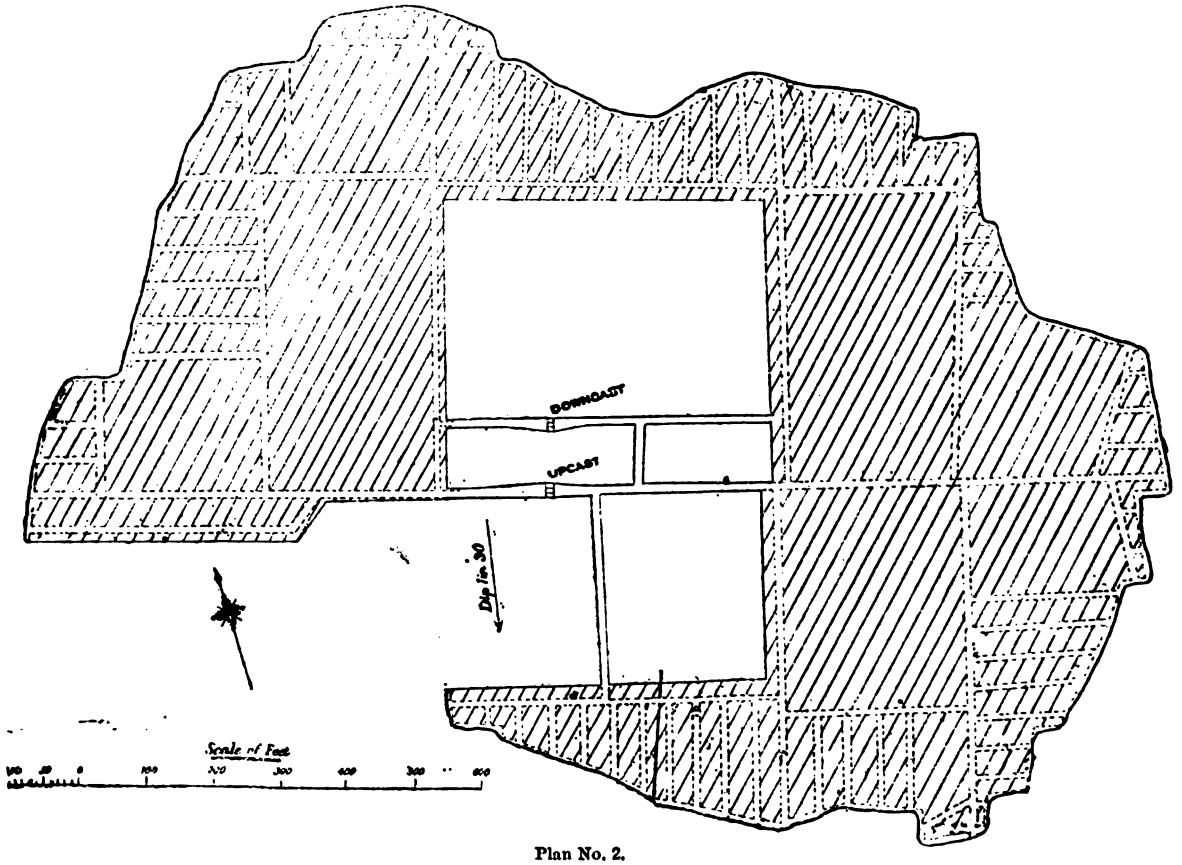
Ventilation.

1. Plan No. 2 shows longwall workings in a 4 feet seam which gives off a considerable quantity of firedamp. Show on the plan how you would ventilate them, giving the quantity of air in each current, and showing the screens, stoppings, air crossings, doors and regulators. Criticise the plan so far as ventilation is concerned. (7)

2. Describe the modes of erecting brattice partitions with which you are acquainted, and the circumstances in which each is applicable. (7)

3. In a longwall working, gas bursts up from a thin seam of coal 20 feet below the pavement. What precautions would you take to deal safely with this? (6)



Plan No. 2.

Competition Questions.

An award of 5s. will be made to the sender of the best set of answers to the questions given below, and 2s. 6d. to the sender of the second best set. Answers to be as brief as possible, and sketches must be made when necessary.

Envelopes to be marked "COMPETITION," and to reach us before July 10th, 1896.

(1) What is anthracite and where is it principally found?

(2) What natural systems of division are found in coal seams, and how does their position affect the working?

(3) What is longwall working and how is it applied (*a*) in a flat seam and (*b*) in one with a high dip?

(4) Explain the uses of the barometer, thermometer, anemometer, and water-gauge in controlling the ventilation of mines.

(5) What special regulations should be observed in mines subject to sudden outbursts of gas?

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Albert Sproson, Wood Lane, Audley, near Newcastle, Staffs.

Commended.—James Skipsey, 25, Co-operative Terrace, Newsham, *via* Newcastle-on-Tyne; J. Laverick, Butterknowle, R.S.O., Co. Durham; T. Hill, Crosby Villa, by Maryport, Cumberland; A. Ratcliffe, 61, Catlow Hall Street, Oswaldtwistle; R. W. Cuthbertson, Hartington House, Staveley, near Chesterfield; G. Brown, Butterknowle, Darlington; A. Fisher, Fern Cottage, Shawcross, near Barnsley; C. E. Scotney, 44, Byrom Street, Hucknall Torkard, Notts; J. McDonald, Crosby Villa, by Maryport, Cumberland; J. Emmerson, Harbottle Yard, Oldgate, Morpeth.

Question 2.—Henry Smith, 6, Waterloo, Wellmitton, Ashton-under-Lyne.

Commended.—W. P. Laws, 28, Pilgrim Street, Murton Colliery, Sunderland.

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Precautions Necessary in the Use of Electricity in Coal Mines.*

By H. W. RAVENSHAW.

ALTHOUGH the use of electricity for lighting and the transmission of power in coal mines is becoming more general, and many of the plants have been running for some years, no serious accidents or explosions have within the experience of the author been traced to its adoption. In some districts, however, where the seams are very fiery, colliery proprietors have refrained from adopting it, preferring to use less efficient or convenient methods, than to run the risk of an explosion. As a matter of fact the risks are few and easily guarded against, and there is no reason why electric motors should not be used in the most fiery mines, if proper precautions are taken in putting down a suitable plant and keeping it in an efficient state of repair.

The precautionary measures to be adopted to minimise risk are briefly as follows:—A shock may cause a man to fall without directly injuring him, and for this reason gear-wheels and other moving parts should be well guarded in the neighbourhood of any switches, resistances, or motors, which might have to be handled during the running of the machinery. All parts of the electric circuit should be covered, so that it is not possible to touch them without deliberately taking off the protecting covers, and the metal cases of switches and junction-boxes should always be connected permanently to earth by a stout wire, either through the tram-road rails or to water-pipes in the vicinity. Motor bed-plates should also be well earthed, especially if the machines be fixed on timber foundations.

Where parts, such as brushes, have to be handled while the circuit is alive, a sound dry timber floor with perhaps a rubber mat, and a wooden handrail for the man to steady himself by, are the best protection. India-rubber gloves are most uncomfortable and clumsy, and are not to be recommended. Great care should therefore be taken in handling the wires connected to the field-magnets.

One of the principal characteristics of electric power is the enormous amount of heat which can be concentrated into a small space, and consequently the high temperature which results. These conditions can be obtained either by an arc being formed, as in the case of a broken wire, when a considerable amount of energy is expended in the air-gap; or by a short circuit, where practically the whole of the power which can be generated is concentrated in a comparatively small part of the system.

* Abbreviated from Paper read at a Meeting of the Federated Institution of Mining Engineers.

The result of a short circuit is easy to deal with, and fuses or other automatic devices can be employed to break the circuit before much damage it done. In certain cases, however, a partial short circuit may cause great heating, although the current due to the reduced resistance may not be sufficient to blow the fuses at the generating station.

Where the shaft is wet, the cable should be run in cast or wrought-iron pipes having joints and junction-boxes made thoroughly water-tight. These protecting pipes should be carried as far into the mine as is necessary to get clear of the water. Where, however, there is no water, armoured cables may be used, care, however, being taken that they cannot be readily damaged by any accident to the cage.

Personally, the author is very much in favour of the use of concentric cables, the external conductor being connected to earth at frequent intervals if not continuously. There are some drawbacks to this arrangement, especially in the switches and motors, but these can be guarded against, and the risk from fire in case of damage to the cables is enormously reduced. In the concentric cable, one conductor is thoroughly well insulated, and the other is stranded over the outside of this insulation. It is advisable to make the cable perfectly water-tight by means of leaden covering, and again to protect it with iron armouring.

Branches and joints should always be made in cast-iron junction-boxes in order that soldering may be avoided. These boxes should contain good solid terminals mounted on slate or porcelain, the opposite poles being well separated from each other. The cables should be taken through stuffing-boxes, and the wire so fixed to the terminals that it is impossible for the cables to be drawn accidentally. The boxes must, of course, be water-tight, the covers having faced joints so that loose packing is not required, as this always gets displaced in time. Where a branch occurs, a switch should be fixed in order that the circuit can be broken for testing or in case of accident. Switch-boxes should be lined with slate to prevent an arc being started on to the metal case.

Where switches are enclosed in metal cases they must be perfectly air-tight. Stuffing-boxes for the cables are always liable to leak, and it is advisable where there is gas to have a separate box carrying the terminals, into which the cables can be brought, the connexions to the inside of the switch being sealed up with bitumen or similar material.

Wire coils are often used for resistances, and are usually flexible and liable to knock against each other or against their supports. They should be so spaced that it is impossible for them to touch surrounding objects, as a more or less dangerous spark might be caused by adjacent coils coming in contact. All resistances should be amply large

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enough to carry all the current that it is possible to put through them without over-heating. In some cases, as on coal-cutters, it would be impossible to fit resistances which would be capable of carrying the current continuously. In this case the switch must never be left in an intermediate position, in fact, it should be made so that it is impossible to leave it in any position except wholly on or wholly off.

The break-down of the insulation between the wire and the frame of the machine is another source of trouble. There should always be at least ¼ inch space between the wire and the metal parts of the machine, mahogany or teak being used to separate the winding from the metal former.

When the circuit of an electro-magnet is broken, a very high pressure is momentarily produced, which will find out any weak places in the insulation, besides causing a bad spark where the circuit is disconnected. With high-tension shunt-magnets, the pressure at breaking is enormous. This danger can be avoided, however, by using a switch which will insert a resistance in parallel with the magnet to be broken, just before breaking, the resistance being left in parallel so that the magnet-coil can discharge itself at its leisure.

Series-magnet coils will also cause sparking at the switch when the motor is cut off, consequently both motor and dynamo should be fitted with a resistance permanently connected in parallel with the series-magnet coil. This resistance absorbs very little power and reduces the spark on breaking the circuit to a very small amount.

By taking the above-mentioned precautions, the sparking at the switches can be reduced to a mere speck and the danger from breakdown is practically eliminated.

In fiery mines it is usual to enclose the armature or the commutator in gas-tight covers, so that an accumulation of gas may not be fired by the sparking at the commutator. It has been contended that it is impossible to fire gas from these sparks; but although a good dynamo will run perfectly at the brushes, there is always a chance of sparking, owing to the brushes chattering, or to a damaged section of the commutator.

In advocating the use of concentric cables and drum-armatures, it must be pointed out that both of these systems have been in extensive use in collieries for some years, and their efficiency has been proved. By their use any defect at once shows itself, and the supply of current is automatically cut off before a fire can occur.

Finally, the experience of some years of working has shown that the transmission of power by electricity can be safely adopted in collieries if reasonable precautions be taken, and a plant be put down of sufficient dimensions to do the work without being overloaded.

Haulage at Wearmouth Colliery.*

By Messrs. R. BELL & McGOWAN.

THE seams worked at Wearmouth Colliery are the Hutton and Maudlin, the whole of the coals being drawn to bank from the Hutton Seam. The Maudlin seam is situated at a depth of 1,596 feet from the surface, and the Hutton seam 1,722 feet. There are three main ways. one running north, another east, and the third south-west. Roads branch off to the right and left, covering the whole of the area worked to the shafts. The ways are 2 feet 5 inches wide, and the tubs carry 9½ cwts. of coal as filled at the face. The ropes in use are of two sizes, that on the north plane having a circumference of 2½ inches, and those in the other planes 2¼ inches. They are made of steel and weigh 6½ lbs. and 5¼ lbs. per fathom respectively. The ropes are purchased in lengths of from 1,000 to 1,200 yards and spliced together, each end being opened out to a length of 15 feet. The total length of haulage and incline ropes in use at the present time is about 24 miles.

The north engine plane, starting from the A pit shaft, immediately after leaving the landing, enters a stone drift 1,380 yards long, rising 1 in 20 to the Maudlin seam. A short distance from the end of the stone drift a branch road runs to the north-west, the main road continuing north for 3,000 feet, where there is another branch road to the north-east. The haulage is on the tail rope and main-and-tail rope systems. The tubs are coupled into sets of 65 tubs, which run at an average speed of 10 miles an hour. When the set is going into the branch districts, the ropes are changed when the empty set stops at the off-takes. The full set after coming out of the landing is stopped just over the off-take points, and the ropes are again changed. The set is then brought out to the top of the incline. Thus far the haulage has been on the main-and-tail rope system, but now it is changed. On reaching the top of the drift the speed is reduced, and when sufficient of the set is on the incline the main rope is loosed off and the set runs by its own weight, drawing the tail rope with it to the shaft, where it is stopped by the engineman putting the brake on the tail rope drum. The rope is then fastened on to the end of the empty set and drawn up the incline, at the top of which the main rope is coupled on.

The engine, which is situated at the shaft bottom, has two cylinders each 22 inches in diameter, with 48 inches stroke, a steam pressure of 50 lbs. per square inch, and 200 indicated horse-power. The drums are each 6 feet in diameter, with a breadth of 2 feet; the shaft is 9½ inches in diameter, being 10½ inches where the cluth works. This engine has drawn as much as 1,300 tons of coal in one day.

* Abbreviated from Paper read at a meeting of the Student and Associate Members of the North of England Institute of Mining and Mechanical Engineers.

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The Maudlin seam is also worked to the east of the shafts by means of a level drift, the natural conditions being such that at some distance from the shaft the Maudlin and Hutton seams are at the same level. Further to the east, however, the Maudlin seam dips heavily from the shaft, the coals having to be brought up the incline. The haulage from the shaft to the dip is on the main-and-tail rope system, but it afterwards is changed to the single or main rope system. When the empty set reaches the top of the incline, the tail rope is loosed off, and the tubs gravitate down to the bottom, drawing the main rope with them. The distance from the top of the incline to the far landing is 3,420 feet, the difference of level being 167 feet, or a dip of 1 in 20½. Owing to this heavy gradient, sets of only 37 tubs are employed.

The engine, which is geared, has two cylinders of 14 inches diameter, with a stroke of 24 inches, a steam pressure of 70 lbs. per square inch, and an indicated horse-power of 67. The drums are 6 feet in diameter, and have a width of 1 foot 6 inches. The spur wheels are 6 feet 5 inches and the pinion wheel is 2 feet 11¾ inches in diameter, with a pitch of 2½ inches and breadth of face 8⅞ inches. The shaft is 6½ inches in diameter and the journals 5 inches long. The average speed from the far-off landing to the shaft (which includes the slower speed in coming up the heavy bank) is about 9⅛ miles per hour. This engine has drawn 700 tons a day from the present landings.

The south-west engine plane runs for some distance through a stone drift which cuts the Hutton seam at a 36 feet rise hitch. The plane continues in this seam to a dip hitch of 126 feet, which curiously enough is the exact difference of level between the two seams, so at the dip side the Maudlin is on the same level as the Hutton seam is at the rise side. The Maudlin seam alone is worked through this hitch, and as it rises heavily to the west a self-acting incline is worked. The haulage is on an altogether different arrangement to that of the other two main districts. The main road runs to the Maudlin seam, and a double line of rails is laid the whole way, so that the empty set runs in as the full one runs out. The branch roads to the Hutton seam are both on the right side of the Maudlin plane, and the haulage is on the main-and-tail rope system. It is necessary in order to change the ropes that the sockets should always be opposite the off-takes. This can only be managed by running two consecutive sets to the Maudlin seam. For example, supposing one set is run into the Maudlin seam, it is clear that the sockets will not be in this position; but if a second set is run to the Maudiin seam, the ropes will be brought back to their original position, and couplings can now be made for the set to go into either of the Hutton seam district. This changing of the ropes is necessarily done whilst the sets are in the landings. The empty set goes into the Hutton seam, the full set is brought out, and when it reaches the shaft the sockets are in the same position as before, and the ropes can be changed for the other districts.

The engine is of exactly the same size and has the same steam pressure as that on the A pit or north engine plane, and 1,000 tons are being brought to the shaft in a day by this engine from the present landings.

On the fore end of each empty set a full tub is placed, and in the south-east two full tubs when going to the dip landings. These tubs tend to steady the set and prevent its jumping off the rails. The signalling is all done by electric bells, and each landing, in addition, has telephonic communication with the shaft. The return wheels have an extreme diameter of 7 feet with a flange of 5 inches, leaving the diameter where the rope runs of 6 feet 2 inches. The diameter of the axle is 3¾ inches.

The discussion was adjourned until the paper was printed in the transactions of the Institute.

Reports of H. M. Inspectors of Mines.

1895.

West Lancashire & North Wales District.

Persons Employed.—The total number of persons employed during the year was 57,448, which is a decrease of 210 as compared with the preceding year. The number of mines worked were 235, employing 46,587 persons underground and 10,861 above ground, of which 1,925 were females. There have been fewer boys employed, but more women, the number of females employed in 1894 being 1,812. The increase in the number of women is probably due to the extended use of picking belts for cleaning the coal. The total number of hands employed during the last three years has been remarkably constant, being 57,000 odd for each year.

Output of Mineral.—The total number of tons of minerals raised during the year was 14,905,646, which is made up as follows:—Coal, 14,841,935 tons; fireclay, 62,537; ironstone, 69; oilshale, 917; pyrites, 188. The number of tons raised per person employed below ground was 319, and per person employed above and below ground 259. The total production of minerals is 917,300 tons less than in 1894. The tonnage raised per person is less this year than last (being 272 tons for 1894), which points to irregular employment. The average value at the mine may be taken at about 6s. 3d. per ton, or 3d. less than in 1894.

Accidents.—The list contains a total of 79 deaths, as against 72 in the previous year, but although this is so, the year 1895 must be considered highly satisfactory when the average of past years is taken

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into account. During the last three years there has been a marked change for the better, and the deaths are well within the seventies, whilst in former years the deaths have usually reached over ninety. Only one death has been recorded as due to a firedamp explosion. In 1895 the death-rate was 1·438 per 1000 persons employed below ground, 1·104 per 1000 persons employed above ground, and 1·375 per 1000 employed below and above ground.

General Remarks.—In this district there can hardly be any great extension of production, as the collieries, especially in the immediate neighbourhood of Wigan, have been worked many years, and the best of the seams approach exhaustion. Rose Bridge Colliery, the deepest in the coalfield (815 yards) and one of the most successful, has come to an end, with the exception of a few hands employed in a thin upper seam. The most valuable part of the coalfield now remaining lies in the neighbourhood of Leigh, and here a large output may be expected for some time. In the St. Helens and Skelmersdale districts there are fewer collieries in existence now than was the case a few years ago. An important sinking is in progress near Golborne, about four miles south of Wigan, and another is spoken of as likely to be commenced on the Bold Hall estate, between St. Helens and Warrington. Both these sinkings will go to a great depth (700 yards), and will open up valuable seams of coal. The various seams, where they are all in existence, amount to a total thickness of 75 feet of coal. There are upwards of 20 workable seams from 2 to 7 feet thick distributed within 1500 yards of coal measures resting on the Millstone Grit.

The Lancashire coal seams are as dusty as any in the kingdom with the exception, perhaps, of the steam coals in South Wales, and the inspector has endeavoured to impress upon the managers the great danger that exists when shots are fired in dusty main roads when the ventilation is strong. Neither inspection, improved appliances, nor increased skill and knowledge make any very appreciable difference in the number of accidents by falls of roof. It was hoped that something might be done to compel what has been termed "systematic timbering," but up to this time there has been little progress in this direction. In the absence of legislation it is difficult to suggest a remedy, but the inspector believes if the employers would agree to supply the timber to the working places instead of only so far as the shunts much safety would result.

Lancashire employers readily adopt suggestions for the safety of the men, indeed, in many cases, a more vigorous interpretation of important rules is adopted and acted upon than appears to be the case elsewhere.

Inspection Duties.—Two hundred and sixty-three underground inspections have been made, and upwards of 80 inquests attended. The circumstances of every fatality have been carefully inquired into and the site of the accident inspected either by Mr. H. Hall or his assistant inspector, Mr. D. H. F. Mathews.

East Scotland District.

This district comprises Clackmannan, Edinburgh, Fife, Haddington, Kinross, Peebles, Sutherland, Linlithgow, and the eastern portions of Lanark and Stirling.

Output of Mineral.—The total amount of mineral raised during the year was 18,988,524 tons, as compared with 14,513,935 in the preceding year and 17,272,735 in 1893. The output for 1895 was made up as follows:—Coal, 16,232,850 tons; fireclay, 317,680; ironstone, 196,998; oilshale, 2,212,573; other minerals, 28,423. The totals for each county are: Clackmannan, 406,857; Edinburgh, 2,039,039; Fife, 3,971,670; Haddington, 342,251; Kinross, Peebles, and Sutherland, 5,721; Lanark (East), 8,674,187; Linlithgow, 2,224,327; Stirling (East), 1,324,472. The output of mineral per person employed below ground was 422 tons, as compared with 320 in the previous year, and per person employed above and below ground 349, as compared with 265 in the previous year.

Fatal Accidents.—During the year there were 75 fatal accidents causing the deaths of 87 persons. Of these 72 deaths were caused by accidents underground. There is an increase of 12 accidents and 7 deaths as compared with the previous year. Two accidents, each causing one death, were due to firedamp, both of which occurred in oilshale mines. Falls of roof and sides resulting in the death of 40 persons, compared with 39 in the previous year. Many of these would have been prevented by a more systematic use of timber.

Persons Employed.—The total number of persons employed was 54,399, of which 45,042 were employed below ground; the total number employed for the previous year was 54,729.

Inspection Duties.—The work of the district has been carried on by Mr. J. B. Atkinson, assisted by Mr. McLaren and Mr. Johnstone. Every fatal accident has been investigated and nearly all the non-fatal cases.

Midlands District.

This district comprises the counties of Derby, Leicester, Nottingham, and Warwick, under the C.M.R.A., and these counties with Bedford, Berks, Buckingham, Cambridge, Hertford, Huntingdon, Northampton, Oxford, and Rutland under the M.M.R.A. and the Quarries Act.

Output of Mineral.—The total output during the year was 21,643,917 tons, a decrease of 246,741 tons compared with the previous year. This comprises coal, 21,493,347 tons; fireclay, 139,061; ironstone, 6,522; and pyrites, 4,987. The quantity raised per person employed below ground was 344 tons, and per person employed above and below ground 270 tons.

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Persons Employed.—The total number employed was 79,999, being 155 less than in the previous year. There are no females employed at the mines.

Accidents.—There were 53 fatal accidents, resulting in the death of 61 persons. The number of separate fatal accidents reported was 1,670. The death-rate per 1000 persons employed below ground was ·762 and per 1000 employed above ground ·763.

Inspection Duties.—Mr. Stokes attended 35 inquests and visited 302 mines. He was officially engaged 298 days and travelled 15,374 miles by rail and road. Mr. W. H. Hepplewhite made 261 underground inspections besides other surface inspections, attended 21 inquests, was officially engaged 309 days, and travelled 14,657 miles. Mr. H. R. Hewit made 222 underground and 54 surface inspections and attended 14 inquests. He was officially engaged 295 days and travelled 12,935 miles.

DURHAM DISTRICT.

This district comprises the southern part of Durham, Westmoreland, and the North Riding of the county of York.

Persons Employed.—The number of mines worked was 235, and the total number of persons employed was 79,492, which is an increase of 411 persons compared with the preceding year. Of this total 60,577 were employed below ground and 18,915 above ground; only 11 females, all above 16 years of age, were employed.

Output of Mineral.—The total output was 27,525,371 tons, being an increase of 693,933 tons as compared with the previous year, though there is a decrease in the coal output by 950,727 tons. The pits' working days have been less by 2,013 at the coal mines and 201 less at the ironstone mines, or a decrease of 2,304 working days as compared with the previous year. The separate outputs of each mineral are:—Coal, 21,988,738; ironstone, 251,016; oil-shale, 5,285,617. The tons produced per person employed underground was 454, and per person above and below ground 346.

Accidents.—During the year notices were received of 570 accidents, 83 of them being fatal to 85 persons; 4 non-fatal accidents resulted from explosions. The death-rate per 1000 persons employed below ground was 1·221, and per 1000 persons employed above ground ·581, and per 1000 persons employed above and below ground 1·069.

Inspection Duties.—Mr. T. Bell, the inspector, has been assisted during the year by Mr. J. Plummer and Mr. W. Walker. Jointly they made 937 visits to mines, quarries, etc., 465 of which were underground, attended 99 inquests, and travelled 28,023 miles.

Answers to Correspondents.

FORGET-ME-NOT.—Mr. Carter purposes continuing with "Answers to Examination Questions" in an early issue; lack of space necessitated our leaving them out for some short time. The ventilation plans were discontinued because the supply of those given at examinations had run out. However, as the 1895 questions have just been issued we are enabled to present a few more to our readers. We think the special rules for the districts you name are identical.

CYMBRO.—Many thanks for your laudatory remarks on "Mining." Though we are not enamoured of the questions usually given by the S. & A. Dept., it is only fair that our readers should know how they ought to be answered. We have no intention however of doing away with the essentially mining questions which have appeared from time to time.

STUDENT.—(1) A candidate for a colliery manager's certificate must have had five years' practical experience. This does not necessarily mean that he must be actually employed in the mine for that period, though some boards of management require this, others (Wigan and Manchester for example) simply require that the candidates have five years' practical experience, apprenticeship to a mining engineer being accepted as such. (2) Certainly. (3) The five years providing he is of the required age.

Correspondence.

MENSURATION.

Sir,—Would any reader of "Mining" kindly show the working of the following question in its simplest form:—A pit is 16 feet in diameter and 200 yards deep, what is the weight of rock (shale and sandstone) excavated, and how much land will it cover when tipped as a square pyramid 32 feet high?—An answer will benefit many readers of "Mining."

REYNARD.

[Two shillings awarded to sender of best answer.]

MECHANICS.

Sir,—What additional strain is put on a rope if its load of one ton is started at a velocity of three miles per hour instead of being lifted cautiously at the start?

SCOTT DALRYMPLE.

[Two shillings awarded to sender of best answer.]

Editorial Notes.

THE CAUSES OF DEATH IN COLLIERY EXPLOSIONS.—A Parliamentary paper has just been issued on this subject with special reference to the Tylorstown, Brancepeth, and Micklefield explosions. The report has been prepared by Dr. Haldane. From his examination of the bodies of the men and horses killed at the explosions he arrives at the conclusion that the actual cause of death was poisoning by carbon-monoxide. In the second part of his report he gives the result of his investigations under the following heads:—The composition of afterdamp. Action on men and lights of the gases present in or mixed with afterdamp. Action of afterdamp heat and violence along the track of an explosion. Distribution of afterdamp and other gases in a mine after an explosion. Distribution of smoke in underground fires. The positions at which bodies are found after an explosion; and suggestions as to the saving of life in colliery explosions and fires.

THE MIDLAND INSTITUTE OF ENGINEERS.—A meeting of this institute was held on the 13th inst. at Wakefield, under the presidency of Mr. John Nevin. The following papers were discussed:—"Electrical Machinery for Mines," by Mr. R. Kennedy; "The Treatment of Timber for Use in Mines;" "The Sinking of No. 1 Pit at Acton Hall Colliery," by Mr. H. St. John Durnford; "The Eastern Limits of the Midland Coalfield," by Prof. Hull; "Electric Welding," by Mr. T. Scott Anderson; and "Lead and Lap on Winding Engines," by Mr. Hargreaves Walter.

THE MINING INSTITUTE OF SCOTLAND.—A meeting of this institute was held on the 13th inst. at Edinburgh. The president, Mr. G. A. Mitchell, occupied the chair. Mr. D. Baird's paper on "The Duty of Pumping Engines" was discussed, as was also the subject of a paper to be submitted at the next meeting by Mr. J. Barrowman, on "The Health Conditions of Coal Mining." The general opinion expressed was that the occupation of a miner was not an unhealthy one. The Muller smoke and gas mask was exhibited and favourably commented upon.

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Answers to Competition Questions.

GIVEN IN No. 13, VOL. IV.

PUMPING.

(1) What quantity of water could be raised, and from what depth, with an underground pumping engine having a 20in. cylinder, 4ft. 6in. stroke, double-acting working, a 10in. pump also double-acting, the effective steam pressure on the piston being 40lbs.?

Answer.—In order to find the quantity of water that can be raised we must know the area of the cylinder and the area of the pump.

Area of cylinder $= 20^2 \times .7854 = 400 \times .7854 = 314.16$
Allowing $\frac{1}{3}$rd for frictional allowance $= 104.72$

209.44

$209.44 \times 40 = 8377.60$ inches available to power.

Area of pump $= (10^2 \times .7854)$ — size of pump rod $(2.5^2 \times .7854) = 78.5400 - 4.9 = 73.64$ inches.

Then area of cylinder available to power ÷ area of pump = pressure in lbs. that can be supported,

$$\frac{8377.6}{73.64} = 113.7 \text{ lbs.} \qquad \frac{113.7}{2.6} = 43.7 \text{ fathoms}$$

43.7 fathoms × 6 = 262.2 feet high to which water may be lifted.

Quantity = area of pump × 12 = cubic inches.
$\therefore$ $73.64 \times 12 = 883.68$ cubic inches.
277.274 cubic inches = one gallon.

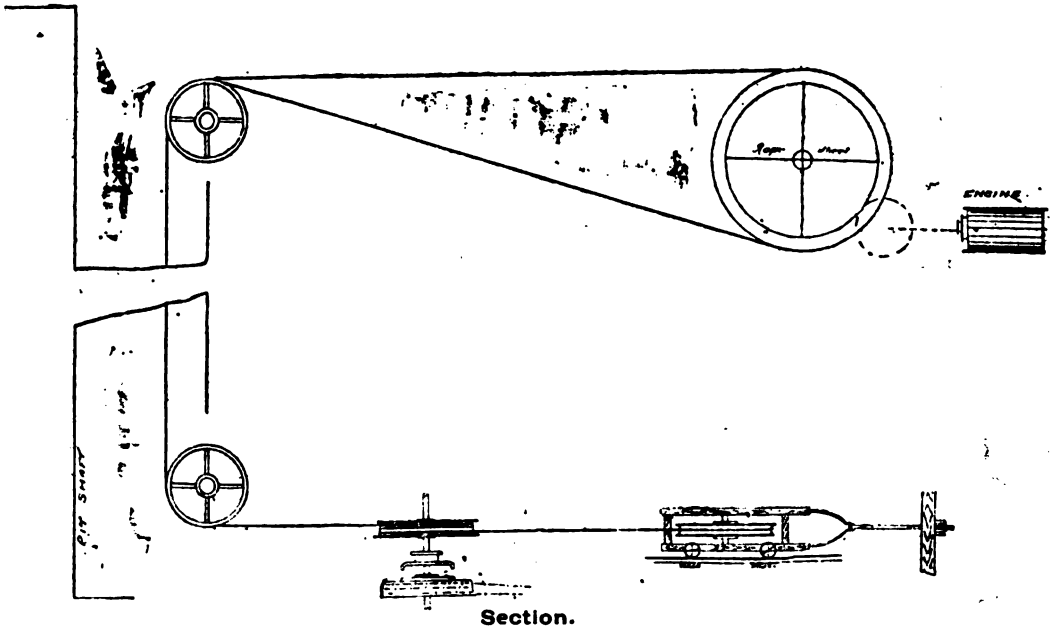
$$\therefore \quad \frac{883.68}{277.274} = 3.2 \text{ gallons per foot of stroke.}$$

Assuming 250 feet per minute as piston speed, $3.2 \times 250 = 800$ gallons per minute = 48,000 gallons per hour.

Thus we have an engine with a piston speed of 250 feet per minute, making a 4ft. 6in. stroke, working a pump with a 10in. cylinder, capable of lifting 800 gallons per minute from a depth of 262.2 feet. ALBERT SPROSON.

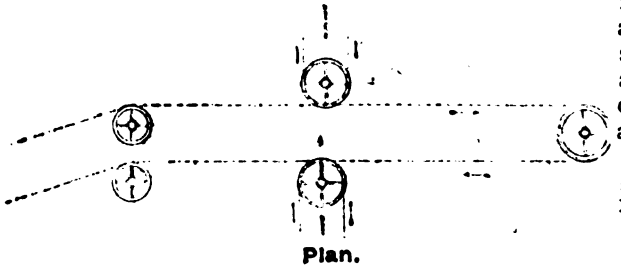
ENDLESS CHAIN SYSTEM OF HAULAGE.

(2) Show a plan of endless chain system of haulage with branch roads; also of driving the chain from the surface by means of ropes down the shaft?



Section.

Answer.—The section represents engine and rope for transmitting power for driving the endless chain haulage underground.



Plan.

The plan represents endless chain haulage with branches and curves worked with the aid of clutch gear in short lengths or one chain all through, but it is advisable to work them with short lengths and put the angles on the one length of chain. By so doing you would make the chain much lighter, and as the heavy chain wears down you can put on a lighter length, which would reduce the weight and the cost of maintenance. HENRY SMITH.

(Answer to Question 3 held over to next issue.)

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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A British Consul on Coal Strikes.

IT appears from a report of Consul Warburton to the Marquis of Salisbury on the trade and commerce of La Rochelle that coal is the principal article dealt in, it now forms nearly three-fourths of the total imports, and is steadily increasing.

The whole of it comes from the United Kingdom, and, on account of the geographical position of the port and its distance from other coalfields, will continue to do so, unless we may lose it by our own fault, which is very likely if the supply should be interrupted or the price considerably increased by labour disturbances, as was the case during the last strike. On that occasion arrangements were being made for replacing English by Belgian or German coal, which would have been carried out if the strike had lasted longer, and this will probably be the result should another one occur.

It is not even so much the increase of price as the dislocation to trade caused by the total stoppage of the supply which the importers cannot put up with, and sooner than risk a recurrence of it they would be ready to pay a high price for coal of somewhat inferior quality from other countries.

It is more important to try and keep a valuable trade like this, because we have lost, or are losing, the business which was formerly done in manufactured goods with this country, partly through the effect of the import duties, but also owing to the neglect of English manufacturers to accomodate themselves to the wants of their customers.

It is an invidious matter to point out shortcomings, but there is no doubt that in many cases the successful competition of French and German with British-made articles is owing to the trouble which has been taken to please the public and give exactly what was wanted in the first instance, and then by degrees the habit of looking to England for them wore out when people found they could get them just as good elsewhere.

I have heard complaints on this score long before the French and German competition had reached the point which it now has, but then buyers had no one else to go to, and were obliged to bear with it. All this is changed now, and merchants can buy goods made in Germany or in France as cheap as in England, while all their little suggestions as to shape and make are carefully and cheerfully attended to. It is no wonder then that this trade has been lost to us, and I do not see any probability of its being regained.

In this view I am confirmed by the opinion of an English gentleman of great experience, who visits La Rochelle as agent for British and American goods, and has travelled over the whole of France for many years, making Paris his headquarters. His opinion is most unfavourable to the position and prospects of British trade. He finds that with regard to the English goods which he sells himself, the French ones are now cheaper and in many cases better than those he can offer.

The protective duties were the primary cause of the change and of inducing persons here to set up manufactories which did not at first reduce prices very much, but experience shows that native competition has always succeeded in time, not only in bringing down prices below the level at which goods could be imported since the duties were put on, but even below the price at which they could be imported if there was no duty at all.

The explanation of this is that, owing to the immense amount of capital lying idle in this country, when one French manufacturer has set up business and is making profit competitors start up and bring down prices to such an extent that certain goods are probably sold at a loss to keep a hold on the buyer for other and more remunerative work.

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Examination Questions with Answers.

By JOSEPH CARTER, First-class Certificated Manager.

Questions given at the Examination for Certificates of Competency for the West Lancashire & N. Wales District, June, 1895, at Wigan.

FIRST-CLASS.

Elementary Education and Ventilation.

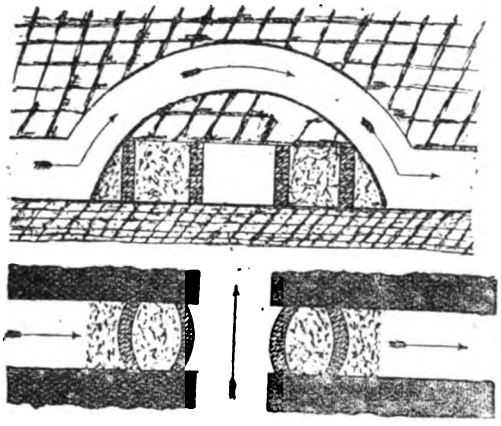
QUES. 1.—If 75,000 cubic feet of air per minute are passing along a roadway 12 feet 3 inches wide by 6 feet 6 inches high, with a water-gauge of 1·75 inches, what is the velocity in feet per minute, and what is the horse-power in the air?

ANS. $\text{Velocity} = \frac{\text{Quantity}}{\text{Area}}$

Thus— $\frac{75000}{12{\cdot}25 \times 6{\cdot}5} = 942$ velocity in ft. per min.

H.P. $= \frac{75000 \times 1{\cdot}75 \times 5{\cdot}2}{33000} = 20{\cdot}68$ H.P. in the air.

QUES. 2.—Describe by a sketch the sort of air-crossing you would adopt in an extensive mine, and give dimensions.



ANS.—I should build an air-crossing as per sketch by having a road driven in the solid, leaving at least 3 yards of rock between the intake road and return, and have the place 10 feet wide by 6 feet high.

QUES. 3.—How often, and when, should inspections for gas and general safety be made in working places?

ANS.—Official inspections for gas and general safety, to comply with the C.M.R.A., should be made before the commencement of a shift and once at least during the shift, but I should say that an inspection be made two or three times during each shift, and at intervals the workmen themselves should inspect their own places several times daily.

QUES. 4.—In a deep and fiery mine what quantity of air per min. do you consider requisite for each person employed?

ANS.—I should consider 500 cubic feet per min. in a fiery mine 5 feet high, and 400 cubic feet in a mine 4 feet high, would be sufficient for each person employed.

QUES. 5.—Mark the ventilation on the annexed plan of a colliery ventilated by a furnace. Show by figures what quantity of air you would expect to have in each split if the total volume of air circulating was 80,000 cubic feet per minute.

ANS.—[Plan not available.]

(To be continued.)

Where Rich Coalfields Abound.

ACTING CONSUL TRATMAN, in a despatch to the Marquis of Salisbury on the trade of Chungking, for the year 1895, says:—"A scheme is under consideration by the high authorities for making a systematic attempt to develop the mineral resources of this province by means of foreign machinery. The project was started by a wealthy native of Ssuch'uan, who laid before the Government at Pekin a most minutely detailed memorandum of the means which he, and those associated with him, considered best for attaining the object in view. The memorandum was also published in the native press. The scheme was referred to the Ssuch'uan Viceroy for a report, and this official, taking umbrage at what he called the attempt of a private individual to obtain a complete mining monopoly—a monopoly, that is, in which the officials would have no share—denounced the whole affair, and warned his subjects by proclamation to have nothing to do with the projector. By the same proclamation the people were informed that the officials will first send deputies to various spots to report on the prospects of profitable mining, that if the outlook is favourable the officials will make first experiments, and that if these are encouraging they will then get together a mercantile company to prosecute the work. This method of procedure has been heard of before in China, and has generally meant failure. It is a pity that it should be applied in this province, where the deposits of coal alone might pay off a national debt. The seams crop out on all sides in the hills, and are followed by the natives in mere burrows, running horizontally, which must be abandoned when the seam dips, or water is encountered. The quality of the output is excellent, but the quantity is necessarily insignificant. The developments await foreign machinery and honest management.

The salt wells in Ssuch'uan afford another example of enormous wealth only partially exploited. With present methods a well may take a score of years to sink, and the brine is laboriously hauled up by buffaloes. Simple machinery would revolutionise the industry.

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Reports of H.M. Inspectors of Mines.

1895.

Newcastle District.

THIS district comprises the north part of the county of Durham and the counties of Cumberland and Northumberland. The chief inspector is Mr. J. L. Hedley.

Persons employed.—The number of persons employed below ground was 56,076, and above ground 13,980, of which 297 were females. The total number employed was 70,056, being a decrease of 1,257 as compared with the previous year; Cumberland contributing 555, N. Durham 87, and Northumberland 615 towards the total. The respective reductions in the numbers amount to 6·7 % in Cumberland, and 1·11 % for the rest of the district.

Output of Minerals.—The depressed condition of the iron and coal trades is responsible for a diminution in the output of coal to the extent of 1,495,467 tons, and of 36,328 tons for all other minerals, giving a total of 1,531,795 tons reduction on the output for 1894. The output of 1894 was however in excess of the average output, owing to the suspension of work in the Scotch and Midland coalfields. The quantities raised were as follows:—Coal, 19,727,302 tons; fireclay, 267,148; shale, 9,176; ganister, 1,618; limestone, 456; giving a total of 20,005,700 tons. The amount of mineral raised per person employed below ground was 356, and per person employed above and below ground, 286.

Accidents.—During the year there were reported 484 separate accidents, resulting in the loss of 74 lives, and injuries to 422 persons. As compared with the previous year there is a decrease of four in the number of deaths, and an increase of 102 in the number of persons injured. This latter is accounted for by a special request made to mine owners to report the more trivial accidents.

Of the fatal accidents one was due to an explosion of firedamp, 26 to falls of roofs and sides, 4 occurred in shafts, 35 by miscellaneous accidents underground and 8 on surface. The death rate per 1,000 persons employed underground was 1·18, employed above ground ·57, and per 1,000 above and below ground 1·05. The quantity raised per life lost was 270,347 tons.

Official Duties.—Mr. Hedley has been assisted, as in previous years, by Messrs. R. P. W. Oswald and G. F. Bell. In addition to office work, attending at Home Office meetings, police courts, &c., and in visits to quarries, Mr. Hedley made 72 underground inspections in addition to surface inspections, and attended 24 inquests. Apart from the time occupied in quarry work, Mr. Oswald was engaged in underground inspections on 102 days in surface inspections alone on 108 days, office work occupied 35 days, and he attended 7 inquests. Mr. Bell was similarly in underground inspections on 110 days, surface inspections alone on 120 days, in office work 25 days, at police courts 2 days, and in attendance at 39 inquests.

Yorkshire and Lincolnshire District.

Persons employed.—There were 88,879 persons employed during the year, which shows a decrease of 2,275 on those employed in the previous year; 7,364 persons under the age of 16 were employed, which represents about one-twelfth of the total number. Only two females were employed. Of the total number of persons employed 71,616 were employed underground, and 17,263 above ground. The number of mines worked was 424, and the average number of days worked per colliery was 226.

Output of Minerals.—The quantity of coal raised in 1895 amounted to 22,807,507 tons, showing a decrease of 634,667 tons as compared with 1894. The yield of fireclay was 249,326 tons, exhibiting a decrease of 21,394 tons. The ironstone produced was 172,813 tons, or a reduction of 15,248 tons on that of the previous year. The production of shale and other minerals in 1895 reached a total of 83,668 tons, as compared with 68,810 tons in the previous year. The total output for 1895 was 23,319,486 tons, as compared with 23,969,765 tons in 1894. The amount of mineral raised per person employed underground was 326 tons, and per person employed above and below ground 262 tons. The average amount of mineral raised per person employed for the ten previous years was 284 tons.

Accidents.—In the years 1894 and 1895 there were 97 and 90 separate accidents respectively. In the former year the result was 100 deaths, and last year 91. Only one explosion of firedamp proving fatal to life and resulting in two deaths occurred during the year. Falls of roof and sides are responsible for 39 deaths, 10 occurred in shafts, 26 are classed as miscellaneous underground, and 14 occurred on the surface. In the year 1895 there was a proportion of one death to every 977 persons employed, and 256,258 tons of mineral produced.

Official Duties.—Mr. F. N. Wardell and his assistants have made 569 underground visits. Mr. Mellor made 376 visits to mines and quarries. He likewise attended a large number of inquests, and in the discharge of his duties travelled over 13,000 miles. Mr. Wilson inquired into 272 accidents at mines and quarries, and made 133 promiscuous inspections at mines, inquired into complaints, and attended inquests. He travelled close upon 14,000 miles.

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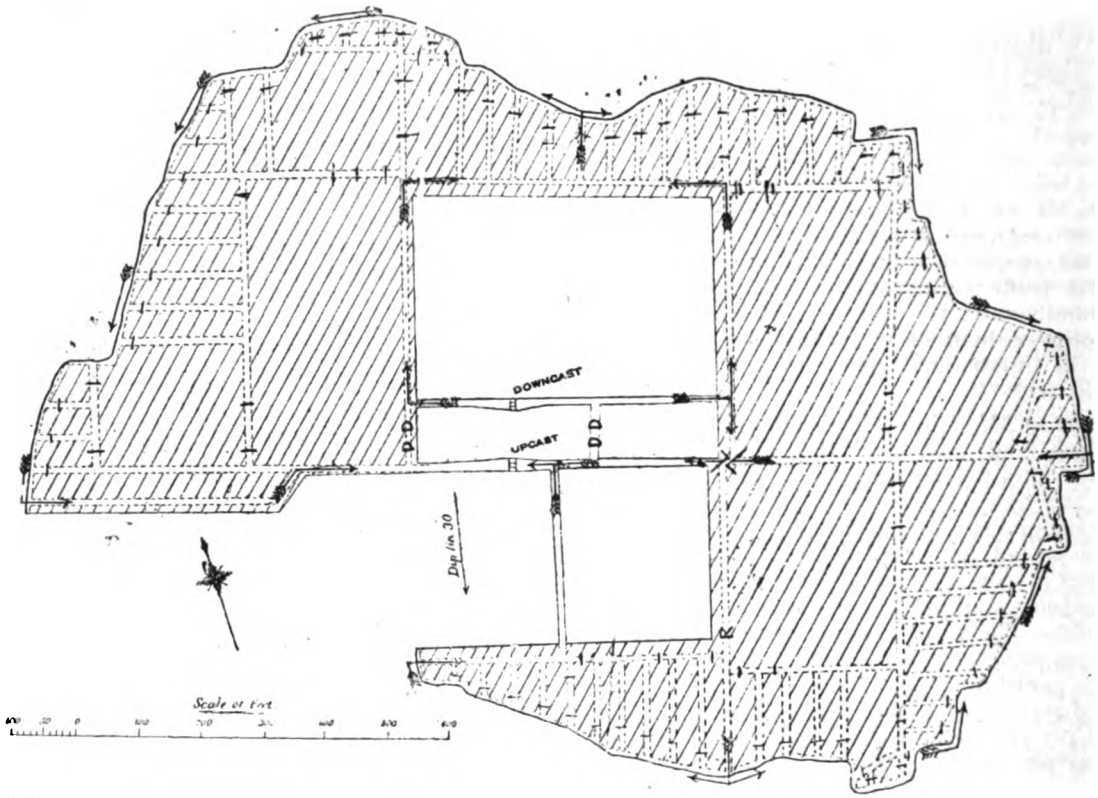
VENTILATION PLAN.

EAST SCOTLAND DISTRICT EXAMINATION (FIRST AND SECOND-CLASS CANDIDATES), 1895.



The position of the roads does not admit of satisfactorily ventilating a fiery mine, and although the roadways at which the air-crossing has been placed are not exactly opposite, we have deemed it necessary to connect them by an air-crossing, the better to ventilate the lower side districts.

Editorial Notes.

LOSS OF LIFE BY EXPLOSIONS.—In answer to a question put in the House of Commons it was stated that the number of lives lost by explosions in coal mines in the United Kingdom during the past six months of the present year was 169, and that the totals for the last six years were, 1890, 319; 1891, 76; 1892, 146; 1893, 175; 1894, 329; 1895, 76.

COAL MINING IN INDIA.—There are altogether about 96 collieries in operation in India: 82 in Bengal, 1 in Madras, 2 in the Punjaub, 2 in the Central Provinces, 4 in Assam, 2 in Beluchistan, and 1 each in Burmah, Central India, and Nizam's dominions. The annual output of India was 1,397,818 tons in 1894 and 2,820,000 tons in 1895.

CHANGES OF WAGES IN THE COAL MINING INDUSTRY DURING 1895.—Mr. H. Llewellyn Smith, in the annual report of the Labour Department of the Board of Trade on "Changes in Wages and Hours of Labour in the United Kingdom," states with reference to the coal mining industry that during the year 1895 the general tendency of wages was downwards as in the previous year. The gross aggregate number of persons affected by all changes reported was 869,577, of whom 869,098 were involved in decreases and only 479 in increases. The number of separate individuals included in the above aggregate was 325,725, of whom no fewer than 325,246 sustained a net fall of wages during the year. No general change took place in the wages of miners within the federated districts of England and Wales, which continued during the year to be governed by the terms of the agreement. In other districts, however, there was a general fall of wages, the wages of Scottish miners falling 6d. per day, while the rates of miners were reduced in Northumberland and Durham 10 per cent. and in South Wales 8½ per cent. No general dispute took place during the year 1895 in the mining industry.

Literary Review.

ENTERING AND EXPLORING A MINE AFTER AN EXPLOSION. By G. M. Bailes, M.E., Certificated Colliery Manager. Price 8d., post free.

As we cannot altogether avoid explosions it is well to know the best means of dealing with them and the measures to be adopted to rescue those who may happen to survive the explosion. The author's brief though explicit description of how the mine should be entered, the exploring conducted, and the survivors rescued, will no doubt be valuable to those who have thus far been fortunate enough to have had no practical experience of colliery explosions.

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The Causes of Death in Colliery Explosions

By Dr. J. Haldane.

THE following is an abridgement of the Parliamentary paper recently issued on "The causes of death in colliery explosions and underground fires, with special reference to the Tylorstown, Brancepeth, and Micklefield explosions."

The Composition of Afterdamp.

The afterdamp of a colliery explosion has not yet been satisfactorily analysed. In the absence of direct evidence, however, it is possible from various dates to obtain a rough idea of its composition. It is evident in the first place that the composition of undiluted afterdamp—by which is meant the residual mixture of gas after deducting the air present—may vary, firstly, according as the explosion is one of dust or of firedamp alone, and secondly, as the proportion of oxygen present in the track of the explosion is sufficient or not to consume the whole of the combustible material (gas or dust) present in the air. The simplest case is that of an explosion of firedamp which is nearly always simply methane or marsh gas, in the presence of excess of pure air. In this case the reaction is as follows:—

$$CH \times 2O_2 = CO_2 \times 2H_2O.$$

The nitrogen (and argon) of the air takes no part in the explosion, hence after the aqueous vapour has condensed the undiluted firedamp will consist of nitrogen 87·23 %, argon 1·05 %, carbonic acid 11·72 %.

This mixture will, under the pre-supposed conditions, be diluted with more or less air, as it requires the presence of from 5 to 6 % of firedamp to render the air inflammable, there will not be more than 10·5 % of oxygen, or 50 % of pure air left in the residual gas. On the other hand if the explosive mixture contained as much as 9·47 % of firedamp, then there will be no oxygen left in the track of the explosion. The undiluted afterdamp from an explosion with excess of air would have a specific gravity of 1·037. This is not much higher than air so long as this afterdamp remained more than about 9 degrees C, or 16 degrees F warmer than (pure) air in the intake roads, and correspondingly more saturated with aqueous vapour, which is lighter than air, it would tend to keep along the roof. The cooled afterdamp on the other hand would lie along the floor, forming a layer similar to that of blackdamp. In an explosion it will of course never occur that the mixture of firedamp and air is everywhere equable. As a rule there will be more firedamp along the roof and less towards the floor. Moreover the air will not be pure, but will contain more or less blackdamp. Besides firedamp the return air of a coal mine contains a variable amount of blackdamp as the following analysis of return air shows:—

Analysis of Return Air.

	Name of Gas.	Podmore Hall Colliery, North Staffordshire. Minnie Pit.		No. 4 Pit.		Talk-o'-th'-Hill Colliery, N. Staffordshire.	
Air	Oxygen.....	20·30	97·13	20·31	97·18	19·77	94·59
	Nitrogen*.....	76·80		76·84		74·79	
	Carbonic acid.	0·03		0·03		0·03	
Black Damp	Nitrogen	1·605	1·77	1·895	2·17	3·64	4·06
	Carbonic acid.	0·165		0·275		0·42	
	Firedamp.....		1·10		0·65		1·35
			100·00		100·00		100·00

* By Nitrogen is meant nitrogen and argon.

From this analysis it is evident that if the return air contained more than 6 % of firedamp, and was explosive, the afterdamp formed would be mixed with from 10 % to 30 % of blackdamp. This blackdamp consists of 87 % of nitrogen and 13 % of carbonic acid, so that its composition is nearly the same as that of pure air. In the case of many fiery pits the foul air would become extinctive to lamps before becoming explosive, and when more than 6½ parts of blackdamp were present to 1 of firedamp the return air would never become explosive, although it might show a slight cap.

The next case is that of pure firedamp explosions in which an excess of firedamp is present in some portions of the explosive air, *i.e.*, more firedamp than would suffice to consume the whole of the oxygen present. It is evident that in most firedamp explosions there must be in parts of the explosion not sufficient oxygen for complete combustion, because the distribution of firedamp and oxygen in a pit is very irregular. In such a case the chemical reaction is complicated, and it is difficult to say exactly what the quantities would be of the various products formed. Instead of carbon dioxide and aqueous vapour a variable mixture of carbon dioxide, carbon monoxide, aqueous vapour, and probably hydrogen will be formed, and these when mixed with about 80 % of nitrogen and any undecomposed firedamp will constitute the afterdamp. The latter will evidently always contain less than 12 % of carbonic acid, but what is of more interest in connection with the present enquiry is the proportion of carbon monoxide liable to be formed. There are reasons for believing that this proportion is by no means high. Excess of firedamp in some way prevents the explosion. A similar excess of an indifferent gas, such as nitrogen, does not exercise this influence. Prof. Clowes' recently found that mixtures containing more than 11 to 13 % of methane would not explode. I have myself found that an ordinary spark would not inflame a mixture containing 11·1 % of "natural firedamp" in air, although with 10 %, a violent explosion occurred. With the latter proportion 9·34 % of carbonic acid, and (according to a calculation) about 2·7 % of carbon monoxide were in the afterdamp. Hence it would seem probable that

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with an excess of firedamp and without dust not more than 3 or 4 % of carbon monoxide will be formed in any part of the track of an explosion.

The case of the afterdamp from a dust explosion is of course the most important, since the explosion usually passes along the main intake airways, it may be assumed that it is practically due to the explosion of dust and air alone, and not a mixture of dust, firedamp and air, though the firing of a small quantity of firedamp may have originated the explosion. It seems probable that there is not a complete combustion of the particles of coal dust, and that what burns is gas distilled off by these particles. After an explosion the bodies of the men and the timbers (especially where little force has been developed) are often found encrusted with melted or partially coked dust. This dust has evidently lost part of the gas which it yields on dry distillation, and doubtless this gas feeds the flame. The gas given off by the coal dust will probably somewhat resemble crude (unpurified) coal gas, much of this will probably be burnt, but an unburnt excess may remain behind to swell the volume of afterdamp. Ordinary crude coal gas is a variable mixture, consisting chiefly of hydrogen and methane (firedamp), together with about 5 % of carbon monoxide, 5 % of higher hydro carbons, about 2 % of sulphuretted hydrogen, and a little carbonic acid and nitrogen. The first portion of gas which comes off on distillation is said to consist, however, chiefly of methane, and the gas which burns in the explosion will probably be this first portion. If burnt in a sufficiency of air for complete oxidation, such gas would yield an afterdamp containing, when undiluted, 87 % nitrogen, 12 % of carbonic acid, and 2 % of sulphurous acid. If burnt in an insufficient supply of air (as is certainly the case in many parts of a dust explosion) the supposed mixture of gas would yield an afterdamp containing, besides about 80 to 85 % of nitrogen, a mixture of carbon dioxide, carbon monoxide, hydrogen, and a little sulphuretted hydrogen, and doubtless other gaseous or volatile products in small quantities. Now it was proved both by the the results of the examination of the bodies found in all parts of the pit, and from the symptoms of the rescuers, that, whatever poisonous gases or vapours existed in the coal dust and afterdamp at Tylorstown, the gas present in the most poisonous proportion was carbon monoxide. Such evidence as I have been able to collect from records of previous explosions, and from those who have themselves been in afterdamp, seems to point distinctly towards carbon monoxide being present in dangerous quantities in the afterdamp of all great colliery explosions. Speaking of the afterdamp met with in several explosions, Messrs. Atkinson record evidence of the probable presence of carbon monoxide. Numerous instances are recorded of persons being overcome by afterdamp though their lamps burnt brightly. In the case of the Elmore explosion, the bodies were examined by Dr. Adamson, and the fact was disclosed that in a number of cases the skin and subcutaneous tissues had a pink colour, which was rightly attributed to carbon monoxide poisoning. I have several times been told of the pinkness of the lips and general lifelike appearance of the bodies after an explosion. Not more than a sixth of afterdamp can be present in the air, which is fatal to the men in cases where lamps are found still burning besides the bodies. Now there must apparently be at least 0·3 % of carbon monoxide in the air. Hence there must be at least $\cdot 3 \times 6 = 1 \cdot 8$ % carbon monoxide in the undiluted firedamp. It does not seem likely that there is much more, otherwise accidents to rescuers (who have no certain guide but their lamps) would probably be more frequent, and men would more often be found with their lamps burning. On the whole it seems probable that undiluted afterdamp contains about 3 % of carbon monoxide on the average.

(To be continued.)

Our Coal Trade with Austria.

A REPORT has been received at the Foreign Office from Consul Haggard, of Trieste, from which it appears that with regard to the trade of Trieste it may be mentioned with reference to coal, in which branch of commerce Great Britain is so much interested, there has been a considerable increase in the importation. The advance in this branch of trade will now probably continue from year to year as fresh industries are developed, when the promised new waterworks for Trieste are taken in hand, and under exemptions from taxation, by means of which the Government is endeavouring to encourage industrial undertakings.

On the other hand a serious competition with the Welsh mines seems to be arising in Westphalia, the coal from which district is now being considerably used by the Austrian Lloyd steamers.

A table is annexed of the importation of coal as compared with 1894:—

Foreign Coal from	Quantity.—Tons. 1894.	1895.
Cardiff	63,859	62,220
Newcastle.....	40,125	26,275
Scotland	17,744	10,606
Hull	3,706	2,089
Liverpool	4,977	416
Germany	4,627	40
Total...	135,038	101,646

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Austrian Coal from		
Istria	23,348	24,092
Dalmatia	16,305	16,003
Bosnia	1,728	1,591
Styria	10,760	12,700
Moravia.....	86	202
Total...	52,227	54,588
Coke	5,963	2,401

In consequence of the very numerous applications from tradesmen and merchants in England for assistance in trade matters, and the consequent enquiries made by this Consulate, it has been prominently drawn to the attention of the Consul how trade with England through Trieste is waning in many different directions through the high duties and since the abolition of the free port. Such a commodity as coal must always hold its own, because the same quality does not exist in Austria and cannot be obtained except from England, but trade in almost everything else is falling off, and in many cases is quite extinct, through increasing home production favoured by high duties on imports from the direct importation in Austrian bottoms—as in the case of coffee—which until recently took place through ports in Great Britain. To specify one or two instances of the above. Since the year 1820 there has been a firm in Trieste that has exclusively dealt in English manufactures of almost every description, except perhaps heavy goods such as coal, metals, and machinery, but now, after 75 years in this miscellaneous business, it is about to close its doors, the manager stating that, although the English goods are infinitely superior, they can no longer compete in the face of the severity of the various duties. The closing of the free port was the last straw, against which he considers it is useless to further struggle, for he has done less and less business since.

Again, in consequence of enquiries from an engineering firm in Scotland, respecting the introduction of its goods, in which ship builders, boilermakers, engineers, etc., are likely to have an interest, it appears that there is now no opening whatsoever in that direction in consequence of the high duties. Information on the subject was speedily solicited from almost all the houses in Trieste likely to be interested in such manufactures, but in every case the same answer was given that importation would not pay.

Another important branch too, of British trade, that has now become extinct is the importation of cement, in fact, export of the Austrian article has already commenced to British territory. Details seem unnecessary, but there is generally a less demand through Trieste for English goods of almost all kinds, chiefly, perhaps, through increased home production protected by heavy tariffs and duties.

Answers to Competition Questions.

Given in No. 14, Vol. IV.

WATER-GAUGE.

(1) Supposing you find the water-gauge very low, and another time you find it very high, in either case what would you think was the matter, and where would you go first?

Answer.—If I found my water-gauge very low compared with the usual water-gauge, I would at once know that it was the cause of a reduced friction, and this caused by one of the following, viz.:—(1st) That the furnace fire was out or very low; (2nd) That the fan was running slow, or it was getting air near the top of the upcast from surface, or that some boards were off the blades of the fan, so that some of the blades simply revolved the air; (3rd) That the air was not doing its duty, but was escaping before reaching the end of its ordinary course, and this may be caused by a door being left open, or by a stopping, or air-crossing being broken through. Now if a fan was used I would of course get the proper reading at fan drift, and then I would at once examine and see that all referred to in the second item above was all right, examining carefully around the enclosed top of upcast, and also see that the fan draft had not broken down. If a furnace was used I would get the reading of water-gauge at the separation doors as is usually the case, and then I would proceed to see if a brisk clean fire was kept. If I found any of the above wrong, I would at once know the reason of the reduced water-gauge, and would remedy it. Failing to find anything wrong, I would at once proceed further into the workings, examining the separation doors, stoppings, crossings, &c., as stated above; either of these may be the cause. If at another time I found the water-guage reading very high, I would know that the air was encountering greater friction, the cause of it being—(1st) That the fan was running at a higher speed than usual; (2nd) That the furnace fire was a great deal hotter than usual; (3rd) That there was a fire burning in or near the upcast. (4th) That a large fall had occurred in one of the main airways, and this is usually the case. Now I would commence my inspection from fan or furnace, and along the airways, inbye, until I found the cause, and then I would immediately take steps to remedy it. Jno. Jones.

SHOT FIRING.

(2) Assuming you are in charge of a drift or stone-head, and you have three shot holes, one in each side and one in the middle, and there was 1½ lbs. of powder in each of the side holes and 3 lb. in the middle one, which would you fire first?

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Ans.—Assuming this question has no reference to the C.M.R.A., which forbids having more than 5lbs. of explosive in any working place, I would fire the middle shot first. This middle hole is called the sumping hole, and it is charged with the greatest quantity of powder on account of having a great amount of work to do and also to prepare the stone for the side or back-end shots. These side shots are put in to square the corners off so that the place will be better to work, and they also make the heading of the right dimensions. If the side holes were fired first, the amount of work for them to do would be too great for the quantity or size of charge used, consequently, a blown-out shot would be the result, thus causing damage and loss of labour and material. While in firing the middle hole first you prepare the heading by making loose ends for the side shots. Therefore the damage of blown-out shots is reduced, less labour expended, and the loss of explosive nil.

CHRISTOPHER GREGORY.

MECHANICS.

(3) A pit is 150 fathoms deep, 250 gallons of water are given off at 40 fathoms, and 400 gallons at bottom. Engine to go 18 hours in the 24. Find size of engine, pumps, rods, plates, and bolts, and give the length and kind of lifts you would fit up.

Answer.—In this case it is evident that only a surface pump would be suitable, as it would only require one engine, whereas if underground pumps were adopted more than one would be required. Therefore, to find out the dimensions of the plant under above conditions we proceed as follows:—

BOTTOM LIFT (BUCKET).—Actual quantity of water this lift has to deal with in 18 hours out of 24

$$= \frac{400 \times 24}{18} + 10\% \text{ for leakage}$$

$$= 533{\cdot}3 + 53{\cdot}3 = 586{\cdot}6, \text{ say } 587 \text{ gallons}$$

$$\therefore \text{Dia.} = \sqrt{\frac{\text{Gallons}}{{\cdot}034 \times \text{Speed}}} = \sqrt{\frac{587}{{\cdot}034 \times 40}} \text{ feet}$$

$$= \sqrt{431{\cdot}6} = 21 \text{ inches nearly.}$$

SECOND LIFT (FORCING).—Actual quantity in this case = 587 + 10% for leakage = 645 gallons.

$$\therefore \text{Dia.} = \sqrt{\frac{645}{{\cdot}034 \times 40}} = \sqrt{474{\cdot}26} = 21{\cdot}7'' \text{ say } 22''$$

THIRD AND TOP LIFT (FORCING).—Actual quantity to be dealt with

$$= \frac{250 \times 24}{18} + 645 + 10\% = 1076 \text{ gallons.}$$

$$\therefore \text{Dia.} = \sqrt{\frac{1076}{{\cdot}034 \times 40}} = \sqrt{791{\cdot}17} = \text{say } 28''$$

Size of Rods, Plates, and Bolts for Bottom Lift:—

$$\text{Rods} = 12000 \times A = 21^2 \times {\cdot}7854 \times 50 \times 2{\cdot}6 \times 30$$

$$12000 \times A = 346{\cdot}3 \times 3900$$

$$12000 \times A = 1346670$$

$$A = 112 \text{ sq. ins., say } 10'' \times 10''$$

A = sectional area of rods

12000 = tensil strength of pitch-pine

$$\text{Plates} = \frac{\text{Area of bucket}}{\text{Dia. of bucket} + 7} = \frac{346}{28} = 12{\cdot}3 \text{ sq. ins. of 4 plates}$$

$$\frac{12{\cdot}3}{4} = 3 \text{ sq. inches area of 1 plate} = 6'' \times \tfrac{1}{2}''$$

Plates will be 12′ long × 6″ × ½″

$$\text{Bolts} = \frac{\text{Area of rod}}{10} = \frac{100}{10} = 10 \text{ sq. ins.} = \text{area of 24 bolts}$$

$$\frac{10}{24} = {\cdot}5'' \text{ area of 1 bolt } \sqrt{\frac{{\cdot}5}{{\cdot}7854}} = {\cdot}79'' \text{ say } \tfrac{7}{8} \text{ dia.}$$

Size of Rods, Plates, and Bolts for Second Lift:—

Rods = pressure on plunger =

$$22 \times 22 \times {\cdot}7854 \times 60 \times 6 \times {\cdot}434 = 59092 \text{ lbs.}$$

Making the rods of ⅔ of wood and ⅓ of iron we have

$$\text{Cu. ft. of wood} = \frac{59092 \times \frac{2}{3}}{50} = 794{\cdot}5 \div 360 = 2 \text{ sq. ft.}$$

say 17″ × 17″ size of rod.

$$\text{Cu. ft. of iron} = \frac{59092 \times \frac{1}{3}}{450} = 43{\cdot}7 \text{ cubic feet.}$$

Plates.—The rods will be in 30-feet lengths, necessitating 12 joints and 12 sets of plates, each plate 15 feet long. Therefore, the length of plate required = 12 × 15 = 180 feet, and

$$\frac{43{\cdot}7}{180} = {\cdot}24 \text{ sq. feet} = 34{\cdot}5 \text{ sq. ins.} \div 10 \text{ ins.}$$

= thickness of all the plates = 3·45 ins.

This would make 4 plates at each joint ·86″ thick = ⅞″ × 10″ broad.

$$\text{Bolts} = \frac{\text{Area of rod}}{10} = \frac{289}{10} = 28{\cdot}9 \text{ area of the bolts}$$

Taking 30 bolts at each joint we have $\frac{28{\cdot}9}{30} = {\cdot}96$

$$\text{Area of 1 bolt} = \frac{{\cdot}96}{{\cdot}7854} = 1{\cdot}22'' \text{ say } 1\tfrac{1}{4}'' \text{ dia. of bolt}$$

Wood saturated weighs 50 lbs. per cu. ft.

Iron weighs 450 lbs. per cu. ft.

Size of Rods, Plates, and Bolts for Top Lift:—

Rods = pressure on plunger =

$$28 \times 28 \times {\cdot}7854 \times 40 \times 6 \times {\cdot}434 = 64136 \text{ lbs.}$$

$$\text{Cu. ft. of wood} = \frac{64136 \times \frac{2}{3}}{50} = 855 \div 240 = 3 \text{ sq. ft.}$$

say 20″ × 20″ size of rod.

$$\text{Cu. ft. of iron} = \frac{64136 \times \frac{1}{3}}{450} = 47{\cdot}5 \text{ cubic feet.}$$

Plates.—There will be 8 joints and 8 sets of plates 15 feet long. Length of plate = 8 × 15 = 120 feet, and

$$\frac{47{\cdot}5}{120} = {\cdot}36 \text{ sq. ft.} = 51{\cdot}8 \text{ sq. ins.}$$

Taking breadth of plates at 12″ we have $\frac{51{\cdot}8}{12} = 4{\cdot}3''$

= thickness of all the plates.

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This will make 4 plates at each joint 1 inch thick.

$$\text{Bolts} = \frac{\text{Area of rod}}{10} = \frac{400}{10} = 40, \text{ area of 30 bolts}$$

$$\therefore \frac{40}{30} = 1{\cdot}3 \text{ area of 1 bolt} = \sqrt{\frac{1{\cdot}3}{{\cdot}7854}} = 1\tfrac{1}{8}\text{" dia.}$$

Size of Engine.—I would use a direct-acting pumping engine 55 inches diameter.

$$\text{Dia. of Engine} = \frac{\text{Foot pounds of work}}{{\cdot}7854 \times \text{pressure} \times \text{speed} \times {\cdot}6}$$

$$\text{Dia.} = \sqrt{\frac{6646200}{{\cdot}7854 \times 100 \times 40 \times {\cdot}6}} = \sqrt{3525} = 55\text{"}$$

The length of stroke = 8 ft. and 5 strokes per. min.

$$\text{H.P. of Engine} = \frac{6646200}{33000} = 200 \text{ nearly}$$

SUMMARY OF DIMENSIONS.

Bottom Lift (Bucket):

Diameter of Set.. = 21" nearly
Rods (pitch-pine) = 10" × 10" × 30' long
Plates ..... = 6" × ½" × 12' long
Bolts (24) ..... = ⅞" diameter

Second Lift (Forcing):

Diameter of Set.. = 22"
Rods (pitch-pine) = 17" × 17" × 30' long
Plates ..... = 10" × ⅞" × 15' long
Bolts (30) ..... = 1¼" diameter

Top Lift (Forcing):

Diameter of Set.. = 28"
Rods (pitch-pine) = 20" × 20" × 30' long
Plates ..... = 12" × 1" × 15' long
Bolts (30) ..... = 1⅜" diameter

Diameter of direct-acting engine = 55 inches
Length of stroke ..... = 8 feet
Strokes per minute ..... = 5
Steam pressure ..... = 100lbs. sq. inch
Horse-power of engine..... = 200

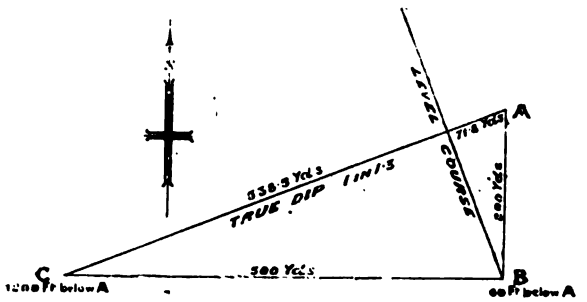
T. GRAHAM.

(Held over from last issue.)

BORING.

(3) A seam of coal crops on a hill top; 200 yards due south of the outcrop, and 160 feet below it, it crops again; a borehole is put down 500 yards due west of the latter place, and finds the coal at a depth of 1,200 feet below the first outcrop, what is the true strike and dip of the seam?

Answer.—The length of the third line is found by the rule of the right angle triangle. Square the base and the perpendicular, add them together, and extract the square root:—



$$^2\sqrt{500^2 + 200^2} = 538{\cdot}5 \text{ yds.}$$

If the coal dips 1200 feet in going 538·5 yards, how far in the same line to dip 160 feet, as

1200 : 160 :: 538·5 = 71·8 yds. = 215·4 ft.

From A measure along AC 71·8 yards and join this point with B. This gives the line of strike or level of the mine. The full dip will be in a line at right angles to the line of strike; this is practically the line AC. The dip of AC is found as follows:—

If it dips 160 feet in 215·4 feet, how much in 1 foot:—

$$\frac{215{\cdot}4}{160} = 1{\cdot}3 \text{ or 1 in } 1\tfrac{1}{3} \text{ feet dip.}$$

Another method is, after finding the distance from A to C, to divide the length by the depth, which is

$$\frac{1615{\cdot}5}{1200} = 1{\cdot}3 \text{ or 1 in } 1\tfrac{1}{3} \text{ feet dip.}$$

The true dip is 1 in 1⅓ feet and S.68W.

JNO. STARK, Cowie Rows, Bannockburn.

Competition Questions.

An award of 5s. will be made to the sender of the best set of answers to the questions given below, and 2s. 6d. to the sender of the second best set. Answers to be as brief as possible, and sketches must be made when necessary.

Envelopes to be marked "COMPETITION," and to reach us before July 24th, 1896.

(1) Describe and illustrate the construction of the Ingersoll Rock Drill.

(2) What are safety explosives, and what precautions are necessary to ensure their acting without flame?

(3) A pit is 16 feet in diameter and 200 yards deep. What is the weight of rock (shale and sandstone) excavated, and how much land will it cover when tipped as a square pyramid 32 feet high?

(4) Give some figures, with dimensions and weights, of steel bars and arches for use in levels in the place of timbers.

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Mineral Statistics for 1895.

THE accompanying table gives the summaries of mineral statistics for mines under the Coal Mines Act for the year 1895. The publication issued by the Home Office also contains the summaries relating to mines under the Metalliferous Mines Act, and of open works under the Quarries Act.

Persons Employed.—The total number of persons employed during the year at all mines was 733,657, of whom 700,284 worked at the 3,512 mines under the C.M.A. and 33,373 at the 724 mines under the M.M.A. Compared with 1894 there is a decrease of 4,956 persons at mines under the C.M.A. and a decrease of 484 persons at mines under the M.M.A. Of the 700,284 persons working at mines under the C.M.A., 564,638, or about 80%, were employed below ground. Of the surface workers 4,837, or about 3½%, were females. At the mines under the M.M.A., 19,660 persons, or about 60%, worked underground, and of the 13,713 surface workers 799, or nearly 6%, were females. At quarries there were 104,625 persons employed.

Output of Mineral.—The total output of mineral at mines under the C.M.A. was 201,738,351 tons. The total quantity of stone and other minerals from quarries in 1895 was 29,813,734 tons.

Fatal Accidents.—At the mines under the C.M.A. there were 868 fatal accidents causing 1042 deaths, as compared with 813 accidents causing 1127 deaths in 1894. Records show that there is no increase in the number of accidents in the later hours of the shift. At the mines under the M.M.A. there were 46 fatal accidents causing 54 deaths, which is an increase of 7 in the number of accidents and 8 in the number of deaths as compared with 1894. At the quarries there were 102 fatal accidents and the same number of deaths.

Summary of Persons Employed and Mineral Production at Mines under the C.M.R.A. for the year 1895.

Districts.	Inspectors.	Number of Mines worked.	Persons employed.	OUTPUT OF MINERALS.						
				Output per employee.	DESCRIPTION.					
					Coal.*	Fireclay.	Ironstone.	Oilshale.	Other Minerals.	Total.
Scotland, East	J. B. Atkinson	317	54,399	349	16,232,850	317,680	196,998	2,212,573	28,423	18,988,524
„ West	J. M. Ronaldson	235	39,657	343	12,559,843	369,978	627,675	23,651	39,220	13,620,367
Newcastle	J. L. Hedley	234	70,056	286	19,727,302	267,148	...	...	11,250	20,005,700
Durham	T. Bell	217	79,492	346	21,988,738	251,016	5,285,617	...	...	27,525,371
Yorkshire & Lincolnshire	F. N. Wardell	424	88,879	262	22,807,507	249,326	172,813	6,172	77,496	23,319,486
Manchester	J. Gerrard	267	39,455	257	10,020,652	122,546	...	...	13	10,143,211
Ireland	J. Gerrard	21	955	137	125,586	4,800	...	...	...	130,386
Liverpool	H. Hall	235	57,448	259	14,841,935	62,537	69	917	188	14,905,646
Midland	A. H. Stoke	318	79,999	270	21,493,347	139,061	6,522	...	4,987	21,643,917
Staffordshire, North	W. H. Atkinson	212	24,723	284	6,061,424	38,152	871,264	3,552	55,692	7,030,084
„ South	W. B. Scott	349	26,715	335	8,648,693	260,256	42,571	..	903	8,953,123
South Western	J. S. Martin	287	44,872	243	10,789,312	82,405	18,953	...	2,140	10,893,010
South Wales	J. T. Robson	396	96,634	263	24,355,373	149,378	9,353	...	65,422	24,579,526
Totals and Averages, 1895		3512	700,284	288	189,652,562	2,314,983	7,231,835	2,246,865	202,106	201,738,351
Ditto 1894		3419	705,240	283	188,277,277	2,164,863	6,814,856	1,986,385	807,699	199,451,018

* The quantity of coal obtained from open quarries was 8,800 tons, making the total of coal, 189,661,362.

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Correspondence.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

SURVEYING.

Sir,—I will endeavour to answer the questions asked by "Jack." There were a few mistakes in the bookings of the survey which I have corrected.

	740	(600 in 2 & 00 in 3)
Line 5	00	(00 in 1 & 510 in 4)
	510	(00 in 1 & 00 in 5)
Line 4	00	(640 in 3)
	640	(00 in 4)
Line 3	00	(740 in 5)
	600	(00 in 3 & 740 in 5)
Line 2	00	(1110 in 1)
N.30°W.	1110	660 centre of shaft
Line 1	·00	(510 in 4 & 00 in 5)

To plot the survey proceed as follows:—Lay down line 1 and measure 660 links and mark shaft, the length of the line being 1,110 links. Then take a pair of compasses and open them to describe a circle whose radius is equal to the length of line 5, using the beginning of line 1 as a centre. Describe an arc so that it will be cut by a similar arc, described from the end of line 1 as a centre, and with a radius equal to the length of line 2. Then a line drawn from each end of the first line to the point of intersection of the two arcs will make a triangle, and this is the first part of the work done, for the chief part of the work lies in finding which of the lines form the first triangle, and the rest is much easier. Now to proceed with the survey. The next triangle is formed upon line 5 by lines 3 and 4. The same process is applied to this triangle as the last one. Use the ends of line 5 as centres, then with radii equal to the lengths of the respective lines, describe the two arcs and draw the lines from the ends of line 5 to the point of intersection, then with all superfluous marks removed, the survey is plotted. (See fig. 1). The magnetic meridian is fixed by means of a protractor. Lay it on line 1 with its centre of the shaft and its meridian on the line, then mark N30°E for line 1 being 30°W of magnetic meridian, then the magnetic meridian must be 30°E of line 1.

We have also four pits, *A B C D*; a line between *A* and *B* connecting them is 200 yards long and lies S60W, *A* and *C* lies S30E, *B* and *C* lies S74E, *B* and *D* lies S30E, *A* and *D* lies S10W. Plot a four-sided figure, *A B C* and *D* being at each corner.

In answer to his second question I annex fig. 2. This is done by laying down line *A B* 200 yards (but it is plotted to a scale of six chains to an inch, to bring yards to links we say 200 × 3 × 1·515 = 909 links), then lay the protractor upon *A* with its centre upon the end of the line *A B*, now move it till line *A B* bears S60W, then mark off *A C* S30E and *A D* S10W. Then move the protractor to *B* and place it so that line *B A* bears N60E, then mark off the bearings of lines *B D* and B C. Then remove the protractor, and draw the lines *A C*, *A D*, and *B D*, *B C*. I think the fig. will show the rest.

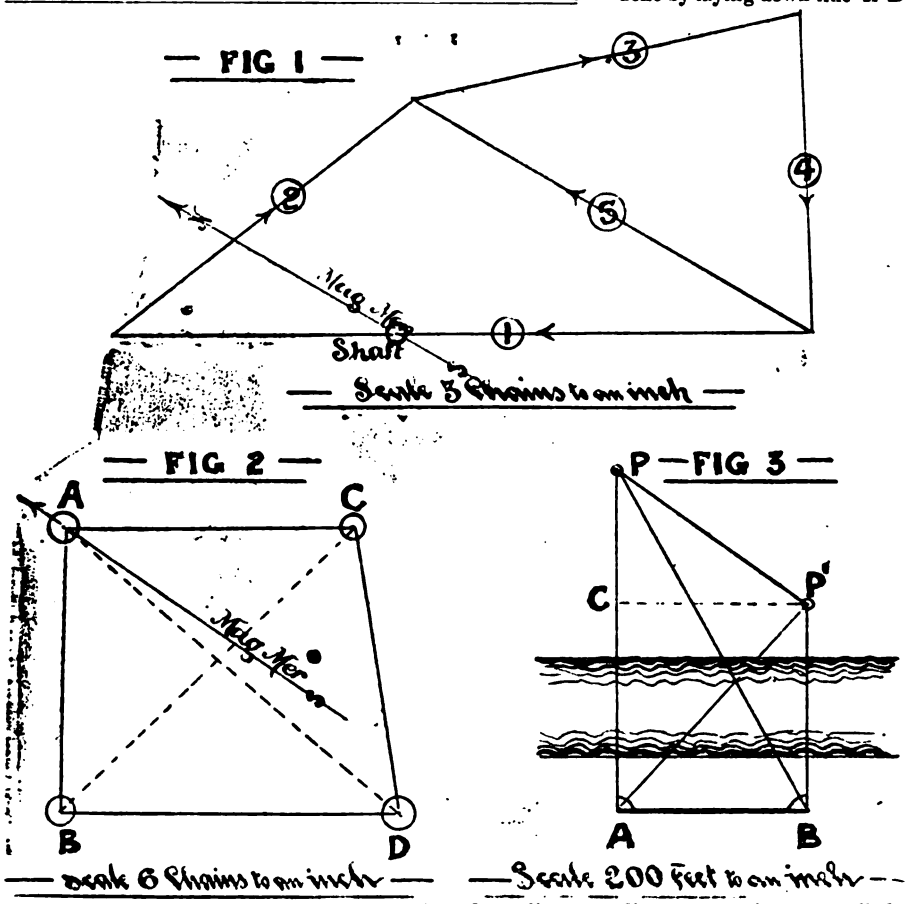
There are two posts on the opposite bank of a river, how are we find their distance apart and their distance from us, assuming that the river runs in a southerly direction and the posts lie in a line S36W?

In answer to his third question I submit fig. 3, PP^1 being the posts. Commence by setting up your instrument, which may be a circumferentor, and take a sight to *P*, then turn the instrument and take a sight at right angles to the first, then move along this line with the circumferentor until a third sight parallel with the first one cuts P^1, then measure accurately the distance you have travelled. Mark the commencement *A* and the finish *B*, and say the distance is 200 yards.

The next thing to do is to find the angles PBA and P^1AB, and calling angle PBA angle *B*, and angle P^1AB we will call angle *A*. Then to find *PA*:—

$$PA = AB \times \tan B.$$

$$\therefore 200 \times 1{\cdot}8040478 = 360{\cdot}809 = PA.$$



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To find $P^1 B$:—$P^1 B = A B \times \tan A$.
$\therefore 200 \times 1{\cdot}0913085 = 218{\cdot}261 = P^1 B$.

And to find $P P^1$:—
$P A - P^1 B = C P$ or $360{\cdot}809 - 218{\cdot}261 = 142{\cdot}548$.

$$P P^1 = \sqrt{142{\cdot}548^2 + 200^2} = 245{\cdot}1$$

The line $C P^1$ is the same length as $A B$, consequently $P P^1 C$ is a right angle triangle, $P P^1$ being the hypotenuse. I have already occupied a reasonable amount of space, and therefore must consider "Jack's" fourth question next issue, for to answer it as it should be answered and to give examples, would be too much for one issue's correspondence allowance. JOHN N. WARDELL.

ECONOMY IN STEAM RAISING.

16, St. Helen's Place,
London, E.C., 1st July, 1896.

Gentlemen,—The attention of our clients, "The Empire Economic Steam Producer Limited," has been drawn to the article in your paper, *Mining*, of the 13th June, 1896, headed "Economy in Steam Raising, by John Rigby." As the statements contained in that article are entirely inaccurate and misleading, and calculated to injure our clients' business very materially, Mr. Rigby, the writer of the article, was communicated with, and as the result of that communication Mr. Rigby has written a letter, dated the 27th June, 1896, addressed to Mr. J. Piggford, and which letter has been forwarded to our clients.—Yours obediently,
JACOBS & LEVINSOHN.

Messrs. Strowger & Son.

The following is an exact copy of such letter:—

"Stanton Iron Works Co.'s Collieries, Ld.,
Near Mansfield, June 27th, 1896.

Dear Sir,—In answer to your enquiry as to the authorship of an article published in *Mining*, dated June 13th, 1896, I beg to say that I am the writer of that article, and that the data therein given is the result of experiments made by me from time to time. I can now see and agree with you that owing to the varying conditions under which these experiments were made by me that the results are not reliable and are for the purpose of comparison worthless. I am sorry I did not ask your advice before sending the article for publication as I feel that my want of thought may have caused annoyance and vexation to those patentees whose invention I have unwittingly underrated. I now beg to apologise through you to these gentlemen, and shall in future take care to be more certain as to the correctness of my figures before rushing into print.—I am, yours faithfully,
JOHN RIGBY.

Mr. J. Piggford, Teversal Collieries, nr. Mansfield."

[We wish to mention that when the article on "Steam Economy" was published, it was not our intention to laud up or cast aspersion on any individual firm, and that we are at all times open to receive communications bearing a fair criticism on any article or letter that has appeared in our columns.—EDITOR.]

To the Editor of "Mining."

Sir,—In your issue of 13th June you publish a tabulated list of results taken from a series of tests made by Mr. John Rigby at the Stanton Iron Works Company's Collieries, at Mansfield, with the forced draught furnaces of the different makers and the natural draught furnace of Messrs. Caddy. Mr. Rigby rightly says "Caddys' is undoubtedly a good patent, the results of course could not be expected to compare with forced draught," but he appreciates the results obtained from that furnace sufficiently highly to honour it with a place in his table. In his synopsis he also says "From the above tests it would appear that the Meldrum furnace gives by far the best results, either judged by the water evaporated, fuel consumed, or work done." On analysing this synopsis, however, the following facts present themselves from the figures given, namely, that 81 cwts. of fuel consumed in the Meldrum furnace produces an average ventilation of 100,285 feet per minute in the pit, equivalent to 1,283 feet per cwt. of fuel consumed. The Caddy furnace for the 36 cwt. it consumes produces an average ventilation of 85,989 feet per minute, equivalent to 2,388 feet per cwt. of fuel used, the useful work done by the Meldrum furnace, therefore, being 93% under that done by the Caddy furnace, that is to say, the Meldrum furnace to do the work of the Caddy furnace will require 69·47 cwts. of fuel, or almost double the quantity used by Caddy. Adding to this the outside fact that the initial cost of the Meldrum furnace is 133% higher, or 2⅓ times that of the Caddy furnace, together with the vital disadvantages attending the working of a forced draught under this system, the so-called best results claimed by Mr. Rigby become absolutely negative.

These remarks are based upon carefully prolonged observations made with both systems in daily operation under the writer's immediate care, and are now made because of aroused interest in Mr. Rigby's results, a wish to prevent steam-users being mislead, and a desire that honour and justice should be given where deserved.—I am, sir, yours faithfully,
W. WILKIE.

July 1st, 1896.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Jno. Jones, Pelydfryn, Aberderfyn, nr. Ruabon.

Commended.—S. Chadwick, Hindley Road, Westhoughton; J. O. Cooper, Pleasant View, Darfield, Barnsley; H. Hall, 15, Poplar Terrace, Ryhill, nr. Wakefield; T. Hill, Crosby Villa, by Maryport, Cumberland; J. McDonald, Crosby Villa, by Maryport, Cumberland; T. Jones, Manor Road, Abersychan, Mon.; H. Causey, 28, Alma Terrace, Bottling Wood, Wigan; J. E. Keefe, Amble, Northumberland; T. Webster, 7, Birchley Rd., Billinge, near Wigan; J. Laverick, Butterknowle, R.S.O., County Durham; A. Hodkinson, 169, Park Rd., Westhoughton; G. Bell, Shotton Colliery, Durham; H. Lowe, Limehurst, Ashton-under-Lyne; W. Ollerenshaw, 46, Grosvenor St., Ashton-under-Lyne; W. Mitchell, Dalharco, Patna, Ayrshire, N.B.; W. Lowe, 176, The Marshes, Hindley Green, near Wigan; E. Ward, Wharncliffe and East Gawber Colliery, Barnsley.

Question 2.—Christopher Gregory, Bransly Villa, Whitehaven, Cumberland.

Commended.—R. Ankers; J. O. Cooper, Darfield, near Barnsley; M. Stovis, Trimdon Grange; W. Stansfield, Wardley Colliery, nr. Newcastle-on-Tyne; S. Chadwick, Hindley Rd., Westhoughton; W. Ellis, Seafield Works, Bathgate, N.B.; S. Wain, Chorley; W. G. Jones, R.C., near Swansea; H. Hall, Ryhill, near Wakefield; G. Tweddell, Lemington-on-Tyne; Wm. Ollerenshaw, Ashton-under-Lyne; R. Derbyshire, Daisy Hill, Westhoughton; T. Peele, Cross, R C. Cottage, Swansea; J. Finch, Hindley Green; T. Hill, Crosby Villa, Cumberland; A. Hodkinson, Westhoughton; J. Stephenson, Wharton Street, Bishop Auckland; J. Jones, Pelydfryn, Aberderfyn, near Ruabon; T. Graham, Carron Colliery, Shieldhill, Falkirk, N.B.; E. Hughes, Tredegar, South Wales; M. Mowbrey, Soothill Lane, Batley, Yorkshire; J. Laverick, Butterknowle; W. Mitchell, Ayrshire, N.B.; T. Wilkinson, Over Hulton, near Bolton.

Question 3.—Thomas Graham, Carron Colliery, Shieldhill, Falkirk, N.B.

Commended.—T. Aitchison, Dunaskin, Ayrshire; T. Hill, Crosby Villa, Cumberland; E. Ward, Wharncliffe and East Gawber Colliery, Barnsley; J. Lyle, Thistle Cottages, Claythorn, Scotland; J. Laverick, Butterknowle; A. Fisher, Fern Cottage, Shawcross, Barnsley.

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'Mining'

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The Causes of Death in Colliery Explosions

By Dr. J. Haldane.

(Continued from last issue.)

The Action on Men and Lamps of the Gases Present in or Mixed with Afterdamp.

THESE gases, so far as is known, are carbonic dioxide, carbon monoxide, nitrogen, firedamp, and sulphuric acid; oxygen may be deficient or absent.

Carbon Dioxide.—Carbon dioxide (or carbonic acid) when present in great excess is a distinctly poisonous gas. It does not act, as is sometimes stated, by merely diluting the oxygen of the air. Air mixed with 50% of carbon dioxide causes rapid death. As shown, however, there can never be more than about 12% of carbon dioxide in afterdamp. In breathing air containing increasing proportions of carbon dioxide, the first distinct effects are felt with about 3 or 4%, the respirations increasing with the percentage both in frequency and depth until with about 6% there is a distinct panting. At the same time slight frontal headache may be felt, which often increases for a short time when fresh air is again breathed. At 7 or 8% the panting is very distressing, and with 10 or 11% the respiratory distress is extreme. With higher percentages consciousness is benumbed or entirely lost, although life may not be endangered, at least for many hours. The action of air containing carbon dioxide on lights seems to depend almost entirely on the reduction of the oxygen percentage. I have found that a light will burn in a mixture containing 75% of carbon dioxide if 25% of oxygen be present. Contrary to what is often stated carbon dioxide has thus very little specific action in extinguishing flame.

Nitrogen (Deficiency of Oxygen).—When nitrogen is added to air it only acts indirectly by diminishing the oxygen percentage. When the oxygen percentage is gradually reduced by absorption of oxygen or (what is exactly the same thing) by addition of nitrogen very little may be felt before the occurrence of impairment of the senses or loss of power over the limbs. At about 12% of oxygen (*i.e.*, with a reduction of 9%) the respirations become just perceptibly deeper. At 10% the respiration is deeper and more frequent, and the lips become slightly bluish. At 8% the face begins to assume a leaden colour, though the distress is still not great. With 5 or 6% there is a marked panting accompanied by clouding of the senses and loss of power over the limbs, which would probably end sooner or later in death. It is probable that any sudden exertion in a marked deficiency of oxygen may lead to temporary loss of consciousness. With 1 or 2% of oxygen loss of consciousness, without any distinct previous warning, occurs within about 40 or 50 seconds. This is quickly succeeded by convulsions which are followed by cessation of respirations. The heart still continues to beat in the case of cats and dogs for from two to eight minutes; in man this period is probably longer. I have myself breathed for half-a-minute without loss of consciousness an atmosphere (containing 0·7% of oxygen) which in 15 seconds produced in a mouse convulsions, followed by almost complete cessation of the respiratory movements. So long as the heart is beating, however feebly, animation may be restored by artificial respiration, though this may be required to be continued for a considerable period. After the breathing has been re-established consciousness may not return for many hours, and very careful treatment may be required to avert death at a later stage. Lights are extinguished when the percentage of oxygen falls to about 17%.

Blackdamp.—As already mentioned blackdamp is a mixture containing about 87% of nitrogen and 13% of carbon dioxide. The action on men and lights follows from what has already been said. Before any real danger can occur the carbonic acid will, by causing severe panting, have given distinct warning of the impending danger. It follows from what has been said that an atmosphere just extinctive to lights by admixture of nitrogen or blackdamp is harmless to men. In case of necessity a man may penetrate into an atmosphere containing four times as much blackdamp as would extinguish a lamp.

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Firedamp.—The action on man of methane or firedamp is exactly the same as that by nitrogen. It occasionally happens that firedamp is mixed with traces of sulphuretted hydrogen. This is easily recognised by the smell of rotten eggs. Sulphuretted hydrogen is excessively poisonous; as little as 0·1 % will result in death. Smarting of the eyes and catching of the breath are signs of imminent danger from this gas.

Carbon Monoxide.—This gas is present in afterdamp smoke and "gob-stink" (*i.e.*, the mixture of gases given off from coal which has spontaneously heated). It differs from other poisonous gases in its particularly slow and insidious action. When the blood of a living animal is saturated with carbon monoxide no oxygen can be conveyed from the lungs to the tissues and death must occur from want of oxygen. The symptoms produced by it are essentially the same as those described as due to a deficiency of oxygen in the air breathed. In air containing about 0·1 % of carbon monoxide the blood will finally become about equally saturated with carbon monoxide and oxygen. If the same blood be afterwards brought into contact with pure air, constantly renewed, the carbon monoxide is gradually driven out. When the blood has become 50 % saturated with carbon monoxide there is loss of power in the legs. These facts make it possible to understand the process of gradual poisoning or of recovery in pure air. With less than 0·1% even a prolonged exposure does not cause complete helplessness; 0·2% would probably (0·3% certainly) cause death in time.

It is of great practical importance to know the times required for dangerous symptoms to develop in atmospheres containing carbon monoxide. The times required may be roughly calculated as follows:—About one pint of carbon monoxide must be absorbed to produce half saturation of the blood of a man. A man at rest breathes about 10 or 12 pints of air per minute, and experiments show that about 60 % of the carbon monoxide inhaled is absorbed. If the air contained about 1% of carbon monoxide it would thus take him about 2¼ hours to absorb a pint. A man who is walking breathes about three times as much air as a man at rest. Hence he might perhaps absorb a pint within an hour. With 0·2% of carbon monoxide the time would be half as long, with 0·3% a third as long, etc. Hence in any case where it is necessary to work in an atmosphere suspected of carbon monoxide, men should be kept in reserve in fresh air. Certain symptoms occur before the stage of complete helplessness is reached, and these should be carefully noted. The first and most important signs are dizziness, weakness in the legs, dimness of sight, and palpitation following any extra exertion. The symptoms become distinct when the blood is about 25 to 30 % saturated. As the percentage increases the symptoms become more marked, until finally at about 50% saturation the limbs are too weak to admit of walking. When more than 16% of afterdamp, or about 0·5% of carbon monoxide is present a lamp will be extinguished, hence the indications of a lamp will at least prevent a man from going into an atmosphere which is very rapidly poisonous from carbon monoxide.

Sulphurous Acid.—About 0·1 % is sufficient to cause death, but the symptoms of irritation caused by it seem to occur long before there could be any danger to life.

Suggestions as to the Saving of Life after Colliery Explosions and Fires.

The first matter to attend to on the part of those above ground is to get fresh air into the pit. As a rule the fan itself escapes uninjured, but the timbering of the passage connecting the fan-drift with the fan is blown out. Delay would therefore apparently be obviated by the provision of a number of light movable flaps opening outward and so made as to close automatically as soon as the pressure from the explosion had relieved itself. Communications between intakes and return near the shafts should be narrow and provided with strong doors, also the air-crossings in the neighbourhood should be in the solid and all stoppings solidly stowed.

The next point to consider is the best means of getting rescue parties down the pit as soon as possible. Very frequently the shaft and cages are damaged, and this causes much delay. To obviate this damage it seems of great importance that the main roads for at least 100 yards on each side of the shaft be so arranged that the floor could always be kept thoroughly wet, and that the sides and roof should either be smooth and entirely free from coaldust or else kept thoroughly wet. Were this done, not only would the shaft be protected, but an explosion coming from one side of the pit would, judging from past experience, be stopped at the shaft. The shaft itself should also be kept wet if it is not so naturally.

The steps to be taken as regards the organisation and direction of rescue parties should be arranged beforehand by the manager and made known to all the officers of the mine so that no unnecessary delay should occur. The danger to rescuers who trust to warning given by their lamps when going into air containing afterdamp should also be clearly explained. As already shown, the presence of a dangerous proportion of afterdamp or other suffocative gas may be detected easily and sufficiently quickly by observing the symptoms of a mouse or other equally small warm-blooded animal. A few white mice might easily be kept for the purpose in the engine-room at the top of the downcast shaft and be taken down in small cages by the rescuers.

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The main point for the rescuers is evidently to push forward with the necessary apparatus and restore the broken doors, etc., with a view to getting fresh air to the bulk of the imprisoned or disabled men who will mostly be near the face. It is not only dangerous, but in most cases practically useless for the rescuers to go into the workings unless they take fresh air with them. After a time the airways near the face will become charged with firedamp and blackdamp. About 5% of firedamp, or 15% of blackdamp, will extinguish a lamp, but about 50% of either of these gases would be required to cause any formidable symptoms to a man. Hence a man may safely go for rescue purposes into air containing either of these gases for a considerable distance beyond the point where an ordinary lamp is extinguished. With the precautions already referred to, electric lamps may be used for penetrating such atmospheres. Any immediate danger would be indicated by the symptoms of a mouse carried by the rescuers. Where it is desirable to go into air which is quite irrespirable an oxygen apparatus of the kind referred to below would be of service.

The saving of life depends principally upon the men in the pit themselves. At the least warning of approaching flame or disturbance a man should at once fall flat; any exertion will hasten the action of afterdamp. For a man near the shaft the best plan would probably be to lie still. For a man in a road far in, the most hopeful way of escape, if consciousness remained, would be towards the return airway or towards the face. Those at the face, or on roads not traversed by the explosion, should on no account hurry towards the shaft by the haulage roads, and when the afterdamp is met the only safe course is to retire to the fresh air. When the afterdamp threatens to pass inwards towards the face much may be done by erecting curtains or stoppings, and by returning behind them, also by opening doors into the returns so that when the ventilation is restored by rescuers the afterdamp may not be carried further inwards. After a few hours, escape will generally be possible, either by the main road or by the return airway. The latter path will have the advantage of being clear of falls. Electric lamps and a few mice should be kept at the face in each district to enable the men to escape. In such cases as explosions occurring near the face escape would still be possible were the men provided at their working places with apparatus for maintaining life in irrespirable gases.

It would require four cubic feet of oxygen to keep a man alive two hours while making his escape to the shaft, or for six hours while at rest. This volume of oxygen can be compressed into a steel cylinder of 1¾ pints capacity. The apparatus required for economically breathing this oxygen must be constructed on the principle known as Regnault & Reiset's respirator. The more elaborate one by Mr. Fleuss is devised on the same general lines. No respirator would be of any use against afterdamp, as there is no known absorbent which could be practically applied to arrest carbon monoxide.

It has been proposed to construct air-tight refuge chambers with strong double doors. It would probably be difficult in practice to make such refuge chambers even approximately air-tight, and the expense would be considerable.

In the case of a fire occurring in or near a main airway the main points are to keep the smoke and gases from entering the workings until the men are withdrawn. The ventilation to the seat of the fire should therefore be cut off. If the fire is in or near the downcast shaft, the fan should be stopped and the top of the upcast opened so that the smoke may pass up the downcast.

(*Concluded.*)

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

(1st) Thos. E. Aitchison, Green Hill, Dunaskin, Ayrshire.
(2nd) Jno. Hy. Senior, 16, Thompson Row, High Street Rawmarsh, near Rotherham.

Commended.—G. Tweddell, 9, Lloyd Street, Lemington-on-Tyne; J. O. Cooper, Pleasant View, Darfield, near Barnsley; W. H. Harrison, Providence Place, Barugh Green, near Barnsley; B. Williams, 18, Griffith Street, Mardy Ferndale, R.S.O.; W. Mitchell, Dalharco, Patna, Ayrshire, N.B.; W. Dickinson, North House, Nettlesworth Pit, near Chester-le-street, Durham; J. Stewart, Bicknall Street, Trimdon Colliery, Ferryhill, Durham; G. W. Hedley, Medomsley Edge, Medomsley, R.S.O., Co. Durham; J. Laverick, Butterknowle, Darlington; R. W. Hall, 1, Railway Street, Murton Colliery, Sunderland; H. Hopper, Cambris, Blyth; T. Williams, 127, Deane Church Lane, Daubhill, Bolton; J. G. Bell, Evenwood, Bp. Auckland; S. Ware, 206, Pall Mall, Chorley.

Competition Questions.

An award of 5s. will be made to the sender of the best set of answers to the questions given below, and 2s. 6d. to the sender of the second best set. Answers to be as brief as possible, and sketches must be made when necessary.

Envelopes to be marked "COMPETITION," and to reach us before August 7th, 1896.

(1) What properties are most valued in steam, gas, and coking coals respectively?

(2) Describe the Lancashire system of working steeply inclined coal seams.

(3) What is meant by *equivalent orifice*, and how is the term applied in discussing the efficiency of ventilating machines?

Literary Review.

GOOD TRADE AND A LIVING WAGE. Price 1s. Published by Messrs. Swan Sonnenschein & Co., Ltd., Paternoster Square, London.

This book, which is written by F. U. Laycock, L.L.B., really explains the causes of the threatened great coal strike, and is a very interesting work. The contents are:—"The State of the Coal Trade," "The Rosebery Conciliation Board," The Minimum Price Principle," and "The Solution of the Problem."

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Firedamp Detectors.

A LARGELY attended meeting of the National Association of Colliery Managers, North of England Branch, was held in the Chemical Lecture Theatre of the Durham College of Science, Newcastle-on-Tyne, on July 4th, Mr. M. Walton Brown, president, in the chair. After the ordinary business of the meeting, Mr. Saville Shaw, Lecturer in Chemistry and Metallurgy at the Durham College of Science, gave a lecture on "The Scientific Principles upon which Firedamp Detectors are based," of which the following is an abstract:—Mr. Shaw said he did not propose to enter into detail concerning any of the various forms of apparatus, but would give a general review of the various principles underlying them, which he would illustrate by simple experiments. The problem which they had before them was: Given a mixture of marsh gas and air, find how much of the former is present? At first sight this appeared to be a simple question in analytical chemistry, but when the answer had to be found in a minute or two, with an apparatus that must be portable, then it became the reverse of easy. There were only two properties of marsh gas which could be turned to account for its detection in admixture with air, viz., its low density, and the fact that it was readily combustible. The determination of its density was affected not by weighing the gas itself directly, but by weighing a body in the gas. When a substance is weighed in the ordinary way, the weight obtained is not the actual weight, but the actual weight less the weight of a column of air equal to the bulk of volume of the substance. A body 1 cubic foot in volume, weighing apparently 1lb. would, therefore, really only weigh 1lb.—1¼ ozs., the weight of a cubic foot of air. . As marsh gas was lighter than air, being only one half as heavy, this substance weighed in marsh gas would weigh about half an ounce heavier than in air, and weighed in mixtures of marsh gas and air it would be heavier in proportion to the amount of marsh gas present. Such was the principle on which several forms of apparatus had been constructed; but unfortunately there were many fatal objections to their use. Carbon dioxide was a gas half as heavy again as marsh gas, which was always present in air and in colliery workings often in considerable quantities; so that it was quite evident that the effect of the lightness of the marsh gas might be entirely eliminated by the presence of some carbon dioxide. The carbon dioxide might be got rid of by delicate apparatus, but there were still other objections to these forms of apparatus as the marsh gas was affected by changes in the barometer, thermometer, and hygrometric condition of the air. There were two other properties of marsh gas dependent on its density which had been utilised, and these were its property of rapid diffusion and the rate at which sound is transmitted in it. By diffusion was meant the property which the little particles of gas had of rapidly mingling one with the other. In the case of a heavy gas, the particles moved at a slower rate than in a light gas. Carbon dioxide in one jar if placed over another jar containing hydrogen would mix, so that a perfectly uniform mixture would be obtained. The particles of which gases are composed are excessively small, and mixing would take place though apparently solid bodies intervened. A porous cylinder, therefore, of unglazed earthenware filled with air, if placed between these two jars, would not prevent the two gases becoming mixed; and if this cylinder were brought into an atmosphere of marsh gas the marsh gas would pass through the little pores of the vessel, but in doing so, owing to the fact that it was considerably lighter than air, it would pass through the pores of the vessel more quickly than the air could get out. Consequently there would be a pressure which could be easily determined; and on this principle the Ansell apparatus was constructed. An objection to this form of apparatus lay in the fact that a rise of temperature in the gas surrounding the porous vessel would have exactly the same effect as though marsh gas were present. Turning to the other property which marsh gas possesses—the rate at which sound travelled in heavy and light gas—this property has been utilised in Prof. Forbes' indicator, but here again precisely the same objections applied. Anything effecting the density of the air would render the instrument unreliable. With reference to the chemical properties of marsh gas, the only one which could be utilised was the fact that it readily burnt, causing heat, and the best of the indicators were constructed on this principle. In some the combustion of the gas was caused by bringing it into contact with the flame of a lamp. In order to understand what took place, it would be necessary to remember that an ordinary flame was made up of three principal parts:—(1) The non-luminous portion, which appeared blue to the eye; (2) the centre of the flame, which was hollow, and which was full of unburnt gas; and (3) a portion which ordinarily could not be seen, but which was a non-luminous mantle surrounding the portion that could be seen. This surrounding mantle, however, if brought into contact with certain gases could be plainly perceived, and therein lay the explanation of the "cap" of the safety lamp. If such a flame were brought into contact with an atmosphere containing marsh gas, the marsh gas would burn and raise the temperature of the outer mantle to such a degree that it could at once be seen. Certain lamps gave better "caps" than others, and the hydrogen lamp gave a bigger cap than all. A spirit lamp also gave a large cap, but the superiority of the hydrogen lamp lay in the fact that it did not give

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off carbon dioxide as the other did, which tended to extinguish the outer mantle. A second method depended upon the fact that combustion could be brought about by bringing the marsh gas into contact with red hot platinum, either platinum wire or finely divided platinum sponge. In the first case the wire must be heated by external means, and in the two instruments working upon this principle the heating was affected by means of an electric current. Platinum was selected on account of its high melting temperature, and on account of the fact that it is distinguished from all other metals by its property of inducing gases to combine, called for want of a better name "catalytic action." Finely divided platinum wire brought into an atmosphere of oxygen and hydrogen would immediately begin to glow and would maintain its red-hot heat for almost any length of time. Liveing's and Morday's indicators utilise this action of platinum. In Liveing's indicator the fact that the luminosity of the wire increased as the temperature arose was made use of; and in Morday's instrument he utilises the increase in length of the platinum wire as the temperature rises and the wire becomes hotter. These two were the best indicators which we possess other than lamps. In another instrument—that of Pitkin—a form of lamp was composed on the principle that where you allow a current of hydrogen to impinge upon a little platinum sponge the sponge becomes red, sets fire to the hydrogen, and the increase of temperature could be registered. Mr. Shaw's lecture was illustrated throughout by numerous experiments, which added greatly to the interest of the proceedings. A discussion ensued, which was adjourned until after the lecture had appeared in the transactions of the association.

The North of England Institute of Mining and Mechanical Engineers.

THE general meeting of this Institute was held on the 14th inst., at the Mining School, Wigan. Mr. Thomas Douglas, the president, was in the chair. A paper on

"THE CAUSES OF DEATH IN COLLIERY EXPLOSIONS,"

by Dr. John Haldane, was read. The author said that in the case of the deaths at the recent explosions at Brancepeth and Micklefield the actual cause was, in almost every case, poisoning by carbon monoxide. The severity of the burns was apt to be exaggerated. There would, however, be many bodies which would be much mutilated. Sometimes these injuries would be caused after death by the falls of stone which followed an explosion. The practical point was not so much the cause of death as the proportion that might be saved.

A paper by Mr. Henry Hall (Her Majesty's Inspector of Mines) on

"SOME ASPECTS OF RECENT COLLIERY EXPLOSIONS"

was read by Mr. Mathews, in the absence of the author. The paper dealt with the initiation of colliery explosions as distinct from their development and extension, the latter branch of the subject having, in the opinion of the writer, received more than its fair share of attention, whilst the initiation of explosions had been somewhat overlooked. The initial flame sprung in most cases from open lights and blasting with gunpowder, though spontaneous combustion and accidental fires were also sources of ignition. Very few explosions, however, could be traced to the latter agencies. It was a noteworthy fact that the more recent colliery explosions had occurred in mines previously thought to belong to the non-dangerous class. At Cammerton (Somersetshire), Blackwell (Derbyshire), Brancepeth (Durham), and Micklefield (Yorkshire), where explosions had recently taken place, the collieries were regarded as so safe that open lights were used, and blasting with gunpowder was resorted to when necessary. At Cammerton the explosion originated in an intake air-road, and was supposed to have been caused by a shot of gunpowder fired there. There were two deaths, and the effects were visible over 1,200 yards of road. This colliery had for 100 years been worked with open lights only. The seam was partially dusty. The coroner's jury declared themselves unable to assign any cause for the explosion. At Blackwell also the explosion occurred in an intake air-road, and was attributed to a shot of gunpowder. There were seven deaths, and the effects were of a sweeping character. The seam was only partially dusty; open lights were used, though safety lamps were occasionally employed, more especially after any cessation of working. The jury attributed the accident to an overcharged shot of gunpowder, but expressed themselves of opinion that the evidence had failed to define any secondary cause. At Brancepeth the explosion occurred under similar conditions, and the effects extended over three miles of roads, resulting in 20 deaths. The seam was dusty. The jury found that the accident was caused by the firing of a shot. At Micklefield the explosion was caused by an open light, though the colliery had been worked with open lights for 23 years. There were 63 deaths. The jury attributed the accident to gas, and exonerated everyone from blame. A shot of gunpowder had in each case been fixed upon as the initiatory cause, but as open lights were in use it must have been difficult to decide with certainty that the disasters were due to blasting. If they were firedamp explosions, how was it that the large body of gas which must have been present escaped being ignited by the open lights previous to the blasting? Out of 164 fatal and non-fatal explosions during 1895, 136

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were due to open lights, and 29 out of a total of 55 deaths were attributed to the same cause. The geographical distribution of the explosions was remarkable. Scotland and South Wales had many more explosions than the English counties, Scotland having almost twice as many as the whole of England together. It was notorious that Scotland and South Wales had adhered to open lights, while these had almost totally disappeared from the English counties. The year 1895 was by no means singular as regarded explosions. The number of deaths by explosions of fire-damp or coal dust during the 22 years previous to 1895 was 4,914, of which 1,583 were set down to open and mixed lights, and 1,853 to blasting with gunpowder or some other flaming explosive. This meant that 70 per cent. of the total deaths were due to these two causes combined. A further fruitful source of accident in open-light collieries arose from sparks from candles or lamps coming in contact accidentally with charges of explosive, either when in transit or in process of charging. Laxity of discipline also sprang from the use of open lights, the men smoking, carrying matches, and behaving as though they were quarrying instead of mining. In a report upon the explosion at the Quarter Colliery, in Scotland, in April, 1895, it was stated that there was found upon the bodies of eight out of the thirteen men killed, matches, tobacco, pipes, and in some cases split nails for opening the safety lamps. Those who advocated the use of the candle held that falls of roof were prevented by the better light afforded. That might have been so when there were only Davy safety lamps, but it was not true with the present improved safety lamps. They were also told that with open lights in general use throughout a mine there could be no sweeping explosion, but this assertion had been belied again and again. The continued use of open lights was also upheld on the ground that, because they had been used 20 or 30 years in a particular mine and nothing had happened, nothing would happen. If, however, an explosion were to happen in every colliery, during its life of 40 or 50 years, there would be colliery explosions almost daily. It was absolutely impossible to be certain that fire-damp would never make its appearance in a mine. The mining profession ought, of their own motion, to put an end to practices which were a flagrant breach of good mining. A large majority of the men who carried out the actual management of the mines were ready to give a decisive vote against the use of both open lights and gunpowder. There was, however, constant pressure put upon them to produce cheaply, to which more attention seemed to be given than to the disposal of the produce at remunerative prices. No premium in the shape of high wages, ought to be paid as a set-off against risk. There was also the influence resulting from close Governmental control, which led to a dilatory and apathetic attitude of mind.

Notes on the Explosion of Coaldust.

Mr. W. J. Orsman read a paper on this subject, which he illustrated by experiments. In the course of the paper he said, "Many theories are held regarding the propagation of an explosion in a dusty mine, the principal one being that the coal dust by the action of heat becomes distilled and yields the inflammable gases necessary to continue the explosion. The production of these gases may undoubtedly have more effect, but the writer is firmly of opinion that the propagation is principally due to the continuous production of carbon monoxide which causes rapid combustion of dust and air as long as they are present."

Mr. N. H. Griffith followed with a paper on

"The Kent Coalfield."

Mr. Griffith said that many years ago the opinion was expressed, upon purely theoretical considerations, that coal measures probably extended below the south-eastern parts of England. Mr. Prestwich in 1871 suggested that the suppositious coal-basin extended for 150 miles, with a breadth of from two to eight miles. A boring made by Mr. F. Brady—one of the authors of that paper—had established the accuracy of this. The bore-hole was commenced 18 inches in diameter. After passing through the first seam of coal the diamond boring system was adopted. The depth from the surface to the top of the coal measures was 1,157 feet. In seams from 2 feet to 4 feet in thickness there was 18 feet of workable coal. There was also good reason to believe that a very considerable thickness of productive coal-measures would be found below the 4 feet seam. The Dover coal of the lower seams compared very favourably with thirty-seven samples of Welsh, and the comparison with Midland and North-country coals was even more favourable. The secondary strata passed through before reaching the coal-measures gave no indications of the presence of water in sufficient volume to cause serious difficulties in sinking. A shaft 17 feet in diameter in the clear was commenced on the Great Fall by Mr. Brady, and carried down 82 feet, meeting with very little water. The sinking of this shaft was being continued by the Kent Coalfields Syndicate, Limited, who were about to commence immediately the sinking of a second shaft, 20 feet diameter, at a distance of 120 feet from No. 1 shaft, and the erection of plant and machinery for a large output of coal.

A short discussion then took place on a paper by Mr. A. C. Kayll, dealing with the "Report of the proceedings of the Flameless Explosives Committee," which concluded the meeting.

On the 15th inst. the members visited the Park Collieries belonging to Messrs. J. and R. Stone, the Maypole sinkings of the Moss Hall Company, and the Roburite Explosives Works. Particulars of these will be given in next issue.

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Reports of Her Majesty's Inspector of Mines for 1895.

North and East Lancashire and Ireland.

Persons Employed.—At the 267 mines in the North and East Lancashire district there were employed last year 39,455 persons, of whom 32,072 were workers underground and 7,383 above ground. This is a decrease of 1,174 persons employed below ground, and an increase of 363 persons employed above ground, compared with the year 1894. In the 21 mines worked in Ireland 955 persons were employed above and below ground during 1895, being an increase of 7 compared with the previous year. Mr. J. Gerrard is the chief inspector.

Output of Mineral.—The quantity and value of the minerals raised in North and East Lancashire during 1895 are shown in the following statement:

Mineral.	Quantity. Statute tons.	Value at the mine. per ton. s. d.	Total value. £
Coal.....	10,020,652	6 7·317	3,311,700
Fireclay ...	122,546	3 0·984	18,884
Pyrites ...	13	—	4
Total ...	10,143,211		3,330,588

In 1895 the total production of coal, fireclay and pyrites was 497,185 tons less than in 1894, coal alone showing a decrease of 508,683 tons. Last year the output per person employed below ground was 316 tons, and per person employed above and below ground 257 tons. The output per person employed underground in 1894 was 329 tons, and per person above and below ground 264 tons. The value has continued to decline, the reduction throughout the year being 9d. per ton. In 1894 the value of the coal averaged 7s. 4·4d. per ton.

In Ireland last year 125,586 tons of coal, of £52,978 value, and 4,800 tons of fireclay, of £840 value, were raised, as compared with 112,604 tons of coal, of £48,931 value, and 6,000 tons of fireclay in 1894. The output per person employed below ground was in 1895 183 tons, and per person employed below and above ground 137 tons.

Accidents.—In North and East Lancashire there were 56 separate fatal accidents and 63 deaths. The death rate per thousand persons employed below ground was 1·777; per thousand persons employed above ground, ·813; and per thousand persons employed below and above ground, 1·597. In Ireland there was one fatal accident which resulted in the loss of six lives.

North Staffordshire.

Persons Employed.—The following table shows the number of persons employed in and about mines, under the Coal Mines Regulation Act, in the different portions of the district during the year 1895:—

	Cheshire.	Shropshire.	North Staffordshire.	
Below ground	2,094	2,965	13,874	18,933
Above ground	494	1,008	4,288	5,790
Totals, 1895.....	2,588	3,973	18,162	24,723
Preceding year, 1894	2,775	3,779	19,348	25,902

In Cheshire there was a decrease of 187 persons, in Shropshire there was an increase of 194 persons, and in North Staffordshire there was a decrease of 1,186 persons, the total decrease being 1,179 persons. The decrease is probably due to the general slackness in the demand for coal which prevailed during most of the year.

Output of Minerals.—The output of minerals for the year was as follows:—Coal, 6,061,424 tons; fireclay, 38,152; ironstone, 871,264; oil shale, 3,552; red clay, 55,168; other minerals, 524; giving a total of 7,030,084 tons, as compared with 7,374,648 in the previous year.

The output of minerals per person employed in the district below ground was 371 statute tons, and per person employed below and above ground 284 tons.

Accidents.—The year under review has been an unfortunate one for the district, on account of the disastrous inundation at Audley Colliery, by which 77 lives were lost, and consequently the loss of life is much above the average. In the preceding year (1894) the loss of life was less than during any year for which statistics are available, and had it not been for the calamity at Audley the loss of life during the year 1895 would not have been so great as in most previous years. The total number of accidents reported during the year 1895, including accidents on private branch railways, &c., was 213, the corresponding number for the previous year being 206. During 1895 there were 36 fatal accidents and 177 non-fatal accidents, resulting in the deaths of 115 persons, and injuries to 188 persons, the figures for the previous year being 27 deaths and 200 persons injured. In 1895 the death-rate per 1,000 persons employed below ground was 5·916; per 1,000 persons employed above ground, 0·518; and per 1,000 persons employed below and above ground, 4·652.

Official Duties.—During the year 1895 Mr. W. N. Atkinson was from home on official business on 277 and 38 nights, and travelled a distance of 10,400 miles. He visited 210 collieries and mines, making underground inspections on nearly 100 occasions; also 55 quarries and associated factories. Mr. Atkinson attended 21 inquests, including adjournments. Eight days were occupied at the Home Office. Mr. H. R. Makepeace was officially engaged on 299 days, of which 4 days only were entirely with office work. He travelled 8,636 miles. He visited 222 collieries and mir making 165 underground inspections. Fort

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days were entirely devoted to the inspection of quarries and factories. He attended 27 inquests and one Board of Trade enquiry.

SOUTH-WESTERN DISTRICT.

The district comprises the counties of Cornwall, Devon, Dorset, Gloucester, Hants, Isle of Wight, Hereford, Monmouth, Somerset, Wilts, and parts of Brecon and Glamorgan. The inspector is Mr. J. S. Martin.

Persons Employed.—At the 287 mines in the district there were 38,022 persons employed below ground and 6,850 persons above ground, making a total of 44,872 persons. In 1894 there were 44,889 persons employed.

Output of Minerals.—The total output of mineral was 10,893,010, made up as follows:—Coal, 10,789,312 tons; fireclay, 82,405; ironstone, 18,953; clay and shale, 200; stone, 2,140. This total compares with an output of 11,254,225 tons in 1894. Last year there was a decrease in the production of coal to the extent of 351,459 tons, fireclay 3,906 tons, ironstone 5,891 tons, and an increase of 41 tons in other minerals, while the same number of persons were employed, thus reducing the work per person above and below ground from 250 tons per person to 243 tons, and the work per person employed below ground from 296 tons to 286 tons.

Accidents.—There were 60 fatal and 168 non-fatal accidents, resulting in 71 deaths, and injuries to 174 persons. Of these 53 fatal and 149 non-fatal accidents, causing 64 deaths and injuries to 155 persons, occurred below ground, while 7 fatal and 18 non-fatal accidents, resulting in 7 deaths and injuries to 19 persons, occurred above ground. The death-rate per 1,000 persons employed below ground was 1·68; per 1,000 persons employed above ground, 1·02; per 1,000 persons employed above and below ground, 1·58. Or, in other words, as has hitherto been the way of expressing it, there were 746 persons employed, and 181,550 tons of minerals raised for each fatal accident, while for each death there were 632 persons employed and 153,423 tons of mineral raised.

NORTH WALES.

The mines in this district include those classed under the Metalliferous Mines Regulation Acts, 1872 and 1875, in the counties of Anglesey, Brecon, Cardigan, Carnarvon, Denbigh, Flint, Merioneth, Montgomery, Radnor, Surrey and Sussex, and the Isle of Man.

Persons Employed.—The total number of persons employed in and about mines in this district during the year 1895 was 7,955, of whom 4,017 worked below ground and 3,938 above ground; of the latter, only 17 were females. Compared with 1894, there is an increase of 310 persons in the total number employed.

Output of Minerals.—The mineral production of two district is shown in the following table:—

Mineral.	Quantity Statute tons.	Value. £
Barytes	811	406
Clay	123	49
Copper ore	8	36
,, precipitate	225	2,755
Gold ore	13,266	16,584
Gypsum	7,416	3,731
Lead ore	15,312	117,624
Manganese ore	782	484
Ochre and umber	1,100	2,700
Slate and slabs (dressed)	139,222	470,668
Stone, &c.	13,094	5,330
Zinc ore	10,796	36,157
Totals	202,185	656,524

Compared with the previous year, there is a diminution in the quantities of barytes, copper ore, gypsum, iron pyrites, manganese ore, ochre, slate, and zinc ore, and an increase in the quantities of gold ore and stone. The total value is £243 higher than in 1894.

Accidents.—The number of separate fatal accidents was twelve, resulting in the loss of the same number of lives. The number of separate non-fatal accidents was seventy-nine. The death-rate per 1,000 persons employed below ground was 2·24; per 1,000 employed above ground 0·76; and per 1,000 persons employed below and above ground 1·51. The underground accidents happened most frequently in the third or the fourth hour of the shift.

Official Duties.—Mr. G. J. Williams travelled 9,849 miles by rail, 834 by road, 150 by sea; Mr. Owen R. Jones travelled 10,201 by rail, 1,646 by road, and 300 by sea; whilst Dr. Foster's journeys amounted to 9,334 miles by rail, 401 by road, and 30 by sea. In the aggregate 542 visits were made to mines, of which 178 included underground inspection, and 581 visits to quarries.

South Wales Institute of Engineers.

A GENERAL MEETING of the South Wales Institute of Engineers was held on the 6th inst., at the Institute, Cardiff. The chair was occupied by the president, Mr. H. W. MARTIN, Dowlais. The following new members were elected:—J. C. Bedlington, Cardiff; W. Forster Brown, Cardiff; Daniel Lewis, Navigation; F. H. Morris, Bridgend; and W. Thomas, Cardiff.

In the course of his inaugural address the president reviewed the position of South Wales since 1857 the year of the formation of the institute, and pointed to the great changes which had taken place and the progress which had been made in the district. After referring to the important works which the Dowlais Iron Co. had erected at Cardiff for the manufacture of the largest steel plates for shipbuilding, he then gave some highly interesting particulars with reference to the sinking of new pits under his supervision at Aberdare Junction by the same Company.

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Hydraulic Pumping Plant (Moore's)

Mr. James Barrow, the author of a paper on this subject, made some supplementary observations. As to the loss of power involved by this mode of transmission, he denied that it was from 20 per cent. to 25 per cent., showing that it was only 12½ per cent. in something like 900 yards of tubing from the hydraulic main rams. Air was no doubt an important contributor to this loss, as was also, to some extent, the compression of the water. With specially-made hydraulic wrought pipes, there was no leakage beyond the slight moisture on the piston rods.

Utilisation of Waste Heaps.

The paper by Mr. John T. Fryer was again considered. An interesting statement from Professor Elliott, of the University College, Cardiff, was submitted, who had subjected some of the concrete bricks and blocks, made from waste heaps, to the strain of the testing maching of the Cardiff Technical Authority, and which showed that a brick made from engine clinker and lime cracked at 0·40 ton and broke to smash at 0·85 ton per square inch, and that a cylindrical block, suggested as part of a pit prop, totally failed at 0·66 tons per square inch. So far as his (the Professor's) experience went, he came to the conclusion that, size for size, the proposed brick-built prop was not stronger than the timber prop.

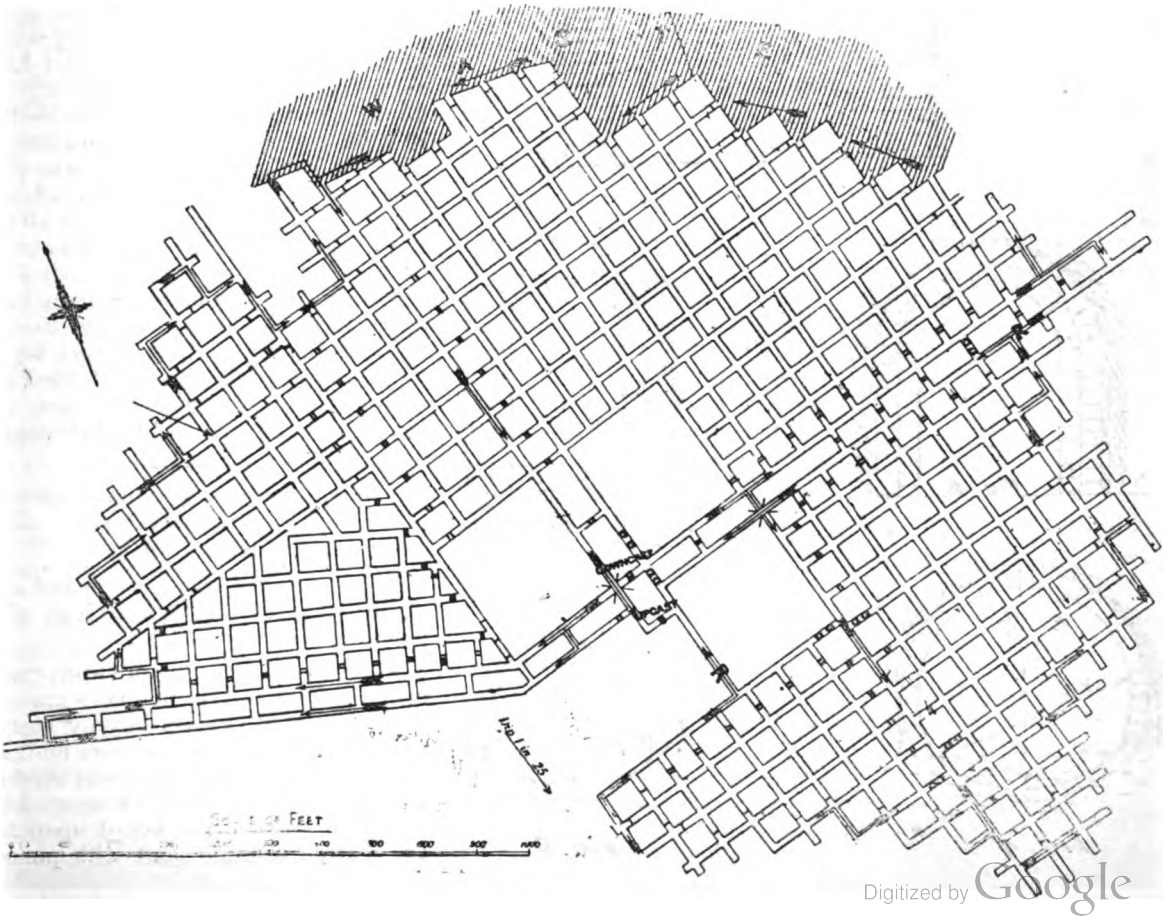
Newbattle Colliery.

The meeting resumed the consideration of the paper of Mr. John Morison on the Lothian coal-field, in connection with the development of Newbattle Colliery.

The President eulogised several features associated with the colliery named, such as the compressing of air by stages, the winding engine, the surface arrangements generally, and the adoption of the balanced rope underneath the cages. With regard to Mr. Morison's experience of water in boring, the president mentioned that at the Aberdare Junction sinking they seldom found large feeders in passing through the same rocks in both pits. Often they got large feeders in one pit and none in the same rock in the other pit.

VENTILATION PLAN.

East Scotland District Examination (First-Class Candidates), 1895.



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Answers to Competition Questions.

GIVEN IN No. 15, VOL. IV.

TOOLS REQUIRED FOR BORING SHOT HOLES.

(1) What tools are required for boring shot holes (*a*) by jumping and (*b*) by single-handed drilling ?

Answer.—(*a*) Jumpers consist of a bar of steel, from 5 to 6 feet long, having a broad curved bit at both ends. This bar is grasped by the miner with both hands, a reciprocating motion is given to it, and at the same time it is slightly turned between each blow, so that the cutting edge strikes in a fresh place each time.

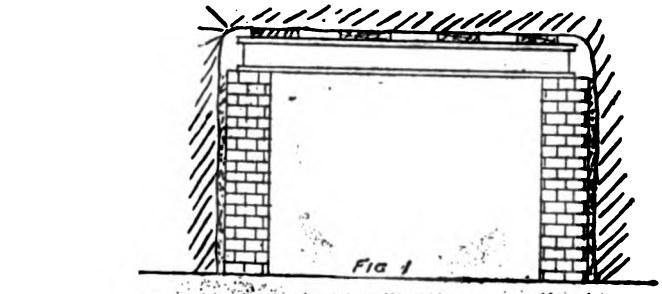
(*b*) In single-handed drilling the tools are smaller than the double-handed sets, and the power used is more effectively applied. These drills or jumpers are light and consequently more rapid, which is an advantage in hard rock, as there is more tendency to break it off in small pieces, requiring less expenditure of power, and there is also less liability of injuring the tools. The end of the drill or jumper which receives the blow is usually made smaller in diameter than the stem, so that the blow strikes dead in the centre. The edge of the drill is also curved to a certain extent, more so for soft rocks than for hard ones, the edge being more acute for the latter class. In ordinary boring the single-handed set consists of a boring hammer, three drills or jumpers, one cleaner, and a stemmer.

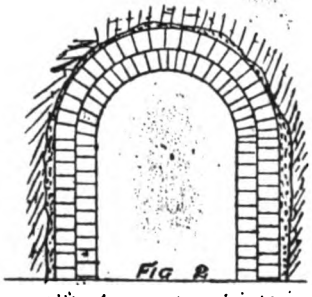
THOS. E. AITCHISON.

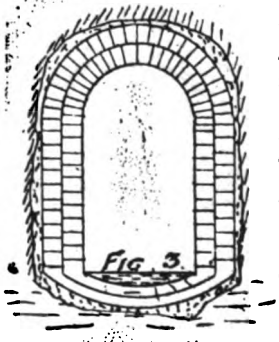
METHODS OF SECURING A LARGE LEVEL WITH MASONRY.

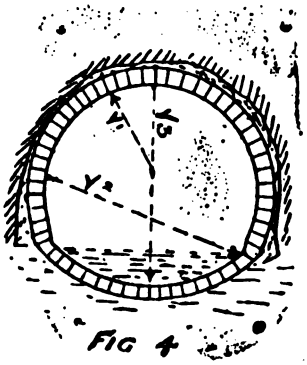
(2) Sketch and describe two methods of securing a large level with masonry.

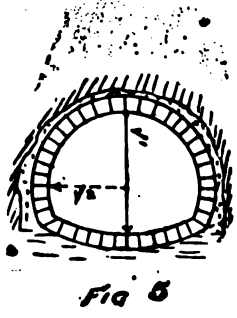
Answer.—The roads or levels require to be firmly secured, and this can be done with masonry by building side walls and beams or girders, made of iron or steel, laid across from one wall to the other and lagged between the girders to prevent any rock falling down (fig. 1). Arches are of various forms. Fig. 2 shows straight side-walls and semi-circular arch, and is adapted for a bad roof and sides but a good floor. Fig. 3 shows the same, but built on an invert. Figs. 4 and 5 show form of arches containing no straight lines. That shown by fig. 4 is for a single road, the upper part is semi-circular, radius half width of road, and the side and invert have same radius equal to width of road. Fig. 5 shows an arch for a double line of rails, the upper portion consisting of top and sides is part of a circle with radius equal to half width of road, and the invert forms part of a circle struck with a larger radius. The thickness of an arch depends on pressure, but it is seldom less than 9 inches or more than 27 inches. All arches should have a lining of sand, and there should be no open spaces left in the rock behind the arch. All timber must be taken out before building up. T. E. AITCHISON.











THE CONSTRUCTION AND USES OF THE CAPSTAN AND SHEAR LEGS OF A PUMPING ENGINE SHAFT.

(3) Explain the construction and uses of the capstan and shear legs of a pumping engine shaft.

Answer.—The capstan or steam crane of a pumping set is in many cases a pair of coupled engines heavily geared to a drum having two or more motions or powers. Another very good capstan consists of a drum and gear-wheel, with full diameter of drum keyed upon the one shaft, a counter shaft with pinion,

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reducing speed say 9 to 1, then another counter shaft connected to the engine by pinion and endless screw. On this shaft two pinions are keyed with clutch between, so that the motion can be reduced to any speed. I have used one of this class, where the engine speed was 300 to 1 of the drum. The engine had 9 inches cylinder with 12 inches stroke, single link engine.

The shear legs are usually two uprights morticed into main crown-trees of head-gear frame and two back stays or spurs down on to the top of the steam crane seat. Their use is to lower and place in position the heavy castings, pipes, rods, etc., into the shaft while the pumps are being put in, and also to be there in readiness if any breakage takes place. These capstans are also used to work in the winding shaft if required, the head-gear wheel being mounted upon a long casting and pushed forward or backward by one man.

THOS. E. AITCHISON.

COMPARISON OF THE WEIGHTS AND STRENGTHS OF ROUND WIRE AND FLAT ROPES.

(4) Compare the weights and strengths of a round wire rope $3\frac{1}{2}$ inches circumference, and a flat one $2\frac{3}{4}$ inches by $\frac{1}{2}$ inch, both of best plough steel quality.

Round Rope:—

Circumference squared = weight per fathom in lbs.
Lbs. per fathom × $4\frac{1}{2}$ = breaking strain in tons.

Flat Rope:—

Breadth × thickness × 8 = weight per fathom in lbs.
Lbs. per fathom × ·8 × $4\frac{1}{2}$ = breaking strain in tons.

A round rope $3\frac{1}{2}$ inches circumference = $3\frac{1}{2} \times 3\frac{1}{2}$ = 12·25 lbs. weight per fathom.

Lbs. per fathom 12·25 × $4\frac{1}{2}$ = $55\frac{1}{4}$ tons breaking strain.

Safe working load for winding purposes = $\frac{1}{10}$ of breaking strain. $\therefore$ $\frac{1}{10}$ of $55\frac{1}{4}$ = 5·5 tons.

A flat rope $2\frac{3}{4}$ inches by $\frac{1}{2}$ inch = $2\frac{3}{4} \times \frac{1}{2} \times 8$ = 11 lbs. weight per fathom.

Lbs. per fathom 11 × ·8 × $4\frac{1}{2}$ = 39·6 tons breaking strain.

Safe working load for winding purposes = $\frac{1}{10}$ of breaking strain. $\therefore$ 39·6 ÷ $\frac{1}{10}$ = 3·96 tons.

J. H. SENIOR.

VARIOUS METHODS OF PREPARING TIMBER FOR UNDERGROUND USE.

(5) What are the best methods of preparing timber for underground use?

Answer.—There have been many schemes tried for the preservation of timber, the following being a few of them:—

Steeping timber in salt brine. (*Moderate results.*)

Steeping the timber in sulphates of copper, zinc, and iron. (*Moderate results.*)

Painting surface with coal tar. (*Moderate results.*)

Whitewashing with quicklime. (*Moderate results.*)

Steeping in a mixture of salt and chloride of magnesium. The wood, which must be dry and free from bark, is then put into a tank containing a mixture of water, nine parts of salt, one part magnesium, and heated by steam pipes to a temperature of about 200° to 212° F. for 24 hours for ordinary wood below 10 inches diameter; if larger, the time should be increased. This process besides preserving the wood makes it incombustible. (*Results good.*)

Steeping in naphthaline. The wood is steeped in a tank of melted napthaline heated to a temp. of 180° to 200° F. by steam pipes for a period of between 2 to 12 hours according to size. This process can be applied to green wood without any long or extensive means of seasoning. (*Results good.*)

Creosote is the only real successful process, and is said to double the life of the wood. In this process the wood is placed into a tank, the doors of which are tightly clamped. The air is pumped out until a vacuum is produced, and then the creosote is pumped in at a pressure of about 150 lbs. per square inch, at a temperature of 120° F. Soft wood absorbs from 8 to 10 lbs. per cubic foot; Hard wood from 6 to 8 lbs. per cubic foot.

THOS. E. AITCHISON.

Correspondence.

MENSURATION.

Sir,—In answer to 'Reynard' I beg to submit the following: A pit is 16 feet diameter and 200 yards deep, what is the weight of rock (shale and sandstone) excavated, and how much land will it cover when tipped as a square pyramid 32 feet high?

Volume in cubic feet = 16 × 16 × ·7854 × 200 × 3 = 120637·44

Take specific gravity of shale and sandstone as 2·5, then

$$\frac{120637{\cdot}44 \times 62{\cdot}5 \times 2{\cdot}5}{2240} = 8415 \text{ tons weight of rock.}$$

Ratio of volume of solid mineral to broken mineral is as 1 is to 1·5, hence volume of rock when tipped will equal 120637·44 × 1·5 = 180956·16 cubic feet.

Rule to find area of base of a pyramid when volume and height are known:— $\frac{\text{Volume} \times 3}{\text{Height}}$ = Area

Then $\frac{180956{\cdot}16 \times 3}{32}$ = 16964·64 square feet, area of base.

$\sqrt{16964{\cdot}64}$ = 130·248 feet, length of a side of square.

Weight of rock = 8415 tons.

Land covered by pyramid = 1 rood 22 poles 8¼ sq. yds. 8 sq. ft. 92·16 sq. in. WM. SLOCOMBE.

MECHANICS.

Sir,—I herewith offer solution to the following question:—What additional strain is put on a rope if its load of one ton is started at a velocity of three miles per hour instead of being lifted cautiously at the start?

3 miles per hour will be $\frac{1760 \times 3 \times 3 \times 2240}{60 \times 60}$ = 4·4 ft. per sec.

1 Ton = 2240 lbs. 2240 × 4·4 = 9856 foot lbs.

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To lift cautiously will be about 6 inches per second :—

$$2240 \times \cdot 5 = 1120 \text{ foot lbs.}$$

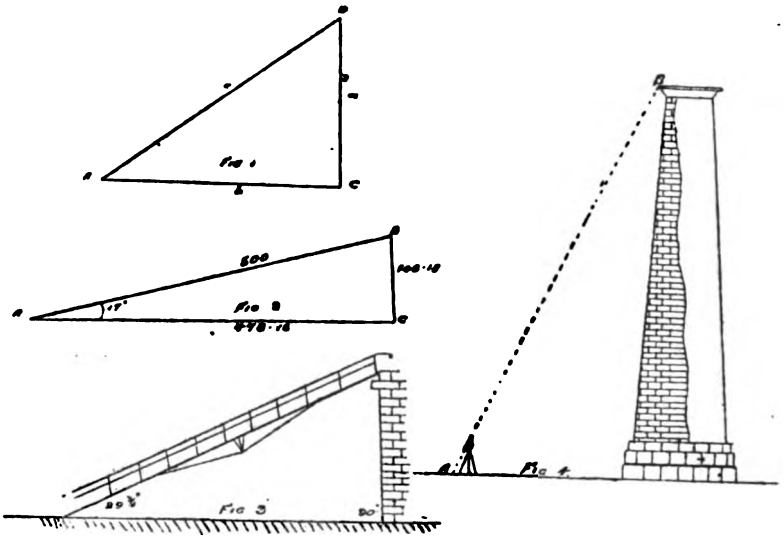
$$\begin{array}{r} 9856 \\ 1120 \\ \hline 8736 \\ 2240 \\ \hline 6496 \\ 4480 \\ \hline 20160 \\ 20160 \end{array} \quad 2240 \overline{)} \quad 2{\cdot}9$$

Therefore, additional strain or weight will be $1\frac{9}{10}$ ton, say 2 tons. Hoping this will help "Scott Dalrymple."

H. GREEN.

TRIGONOMETRY.

Sir,—In answer to "Jack's" query *re* the trigonometrical functions of an angle in a right-angled triangle, which appeared in No. 14, Vol. IV., I wish to submit the following :—



The trigonometrical functions of an angle may be defined as the ratios of the sides to each other of a right-angled triangle containing the given angle. The following is the way they are generally tabulated :—

$$\text{Sine } A = \frac{A}{C} \qquad \text{Cosecant } A = \frac{C}{A}$$

$$\text{Cosine } A = \frac{B}{C} \qquad \text{Secant } A = \frac{C}{B}$$

$$\text{Tangent } A = \frac{A}{B} \qquad \text{Cotangent } A = \frac{B}{A}$$

(See Fig. 1.)

I consider the following a much simpler way of presenting them to the elementary student than the above :—

$\frac{\text{Perp}}{\text{Hyp}}$ = the sine of angle A or sine A $\frac{BC}{BA}$

$\frac{\text{Base}}{\text{Hyp}}$ = the cosine of angle A or cosine A $\frac{AC}{BA}$

$\frac{\text{Perp}}{\text{Base}}$ = the tangent of angle A or tangent A = $\frac{BC}{AC}$

$\frac{\text{Base}}{\text{Perp}}$ = the cotangent of angle A or cotangent A = $\frac{AC}{BC}$

$\frac{\text{Hyp}}{\text{Base}}$ = the secant of angle A or secant A = $\frac{BA}{AC}$

$\frac{\text{Hyp}}{\text{Perp}}$ = the cosecant of angle A or cosecant A = $\frac{BA}{BC}$

Perp = Perpendicular Hyp = Hypothenuse

EXAMPLE I.—An incline plane is 500 yards long and rises at an angle of 17°. What is the horizontal length AC, and the height of B above C ?

ANSWER.—The incline plane is the hypothenuse of the triangle, and is 500 yards long. Now to find the base we will multiply 500, or, the hypothenuse by the cosine A, and to find cosine A we must have a table of natural sines, cosines, &c. (I prefer "Chamber's Mathematical Tables," 4/6.)

Cosine A = ·9563048

∴ ·9563048 × 500 = 478·1524 = horizontal length or base AC

Now to find the height of B above C we multiply 500 by sine A

Sine A = ·2923717

∴ 500 × ·2923717 = 146·18585 = perpendicular

EXAMPLE II.—An inclined gangway rises at an angle of 29°45′ to a height of 28 feet from the ground. It is used for raising timber, hay, &c., from the ground to the heapstead to go down the pit. What is its length, and the length of the base ?

ANSWER.—The perpendicular multiplied by the cosecant equals the hypothenuse.

Cosecant 29°45′ = 2·0152494

∴ 28 × 2·0152494 = 56·4269832 = the length of the gangway, say 56¼ feet.

The perpendicular multiplied by the cotangent equals the base,

Cotangent 29°45′ = 1·7496371

∴ 28 × 1·7496371 = 48·9898388 feet, the length of base.

EXAMPLE III.—It is required to know the height of a colliery chimney. A theodolite is at my disposal, how am I to proceed ?

ANSWER.—In this case the point B is straight above C, and the ground is almost level (fig. 4). Now, I place the theodolite so as to ascertain angle A, which is 70°. I then measure AC = 31·5 feet. Now the base multiplied by the secant A equals the hypothenuse, and the base multiplied by the tangent A equals the perpendicular.

Tangent 70° = 2·7474774

∴ 31·5 × 2·7474774 = 86·545538 = the height of chimney, or the perpendicular of the triangle ABC.

To find the length of line AB :— 31·5 × secant A = AB

∴ 31·5 × 2·9238044 = 92·1098386 = AB

From the above examples it will be seen that hyp × cos = base, or as 1 is to the cosine of the angle so is the hyp to the base, and

Hyp × sine = perp, or as 1 : sine of angle :: hyp : perp
Perp × cosec = hyp, or as 1 : cosecant of angle :: perp : hyp
Perp × cotan = base, or as 1 : cotan of angle :: perp : base
Base × tan = perp, or as 1 : tangent of angle :: base : perp
Base × secant = hyp, or as 1 : secant of angle :: base : hyp.

To insert the above in the correspondence column of your journal is almost too much to ask. It is a great pleasure to me to impart information to my brethren in search of knowledge.

JOHN N. WARDELL.

(We are much obliged to Mr. Wardell for the trouble he has taken in this matter.—ED.)

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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Experiments with Explosives.

THE following particulars of the explosive roburite are culled from a circular presented to the members of the North of England Inst. of Mining and Mechanical Engineers on the occasion of their visit to the Roburite Explosives Works:—

The Roburite Explosives Co., Limited, started manufacturing roburite in 1888, and the works at Gathurst, near Wigan, are of considerable extent, covering 30 acres of ground, and are equal to an output of 10 tons a day. A canal runs through the centre, separating the chemical from the explosive portions of the establishment, and the L. & Y. Railway runs up to the doors. There is thus every facility for sending off large consignments which are despatched daily to all parts of England and the Colonies.

The safety explosive roburite No. 3, as now made, is a mixture of nitrate of ammonia, with di-nitro-benzol, with highly chlorinated naphthalene. The composition of each cartridge is approximately as follows:—

A	Nitrate of ammonia... ...	86 parts
	Chlorinated naphthalene...	2 parts
B	Di-nitro-benzol...	12 parts

Owing to the deliquescent nature of the nitrate of ammonia the finished explosive must be kept out of contact with the atmosphere, and for this reason the cartridges are waterproofed by dipping them in melted wax.

The above Company was the first to really introduce a safety explosive of the nitrate of ammonia class into actual use in England, and its general adoption in the Lancashire district has been followed by most beneficial results. The Company claim that of all the explosives now in use for coal-blasting purposes the explosives made by them are the safest, on account of the introduction of a chlorinated body in small quantities, the gases from which effectually stifle flame. The special advantages of using roburite No. 3 are:—

(*a*) Unlike gunpowder, tonite, dynamite, gelignite, carbonite, and other mixtures, it is impossible to detonate a cartridge of roburite by percussion, fire, or electric sparks. If a cartridge or layer of the explosive be struck with a heavy hammer, the portion directly struck is decomposed, owing to the large amount of heat developed by the blow. The remaining explosive is not in the least affected, and no detonation whatever takes place, whilst nitro-glycerine compounds explode violently.

(*b*) If roburite No. 3 be mixed with gunpowder, and the gunpowder fired, the latter explodes and simply scatters the roburite without affecting it in the least.

(*c*) If a cartridge be half filled with a nitro-glycerine explosive such as dynamite, gelignite, or carbonite, and the other half with roburite No. 3, and a weight be allowed to drop on the dynamite end, complete detonation of the cartridge takes place, the explosive wave travelling the whole length of the cartridge. If the roburite end be struck no detonating wave is set up and no explosion takes place.

(*d*) Explosives of the nitro-glycerine class are much more susceptible to detonation than those of the nitrate of ammonia class. This can easily be shown by laying cartridges of an explosive on the ground at small distances apart. One cartridge only, primed with a detonator, is fired, the others detonate or not according to the nature of explosive used and the distance the cartridges are from one another.

(*e*) Tape fuse may be inserted into cartridges and lit with nitro-glycerine explosives, such as carbonite; the cartridge will fire and burn away. With roburite No. 3 nothing happens.

(*f*) A cartridge of gunpowder may be fired in a heap of roburite No. 3. The latter is only scattered, not exploded.

(*g*) A heap of roburite would quietly and slowly burn away from the outside. The nitrate of ammonia in burning would absorb so much heat, and generate so much steam, as to prevent any rapid ignition, in fact it can be proved that if a cartridge of roburite containing a detonator be thrown on to a blazing fire the roburite will slowly burn away for some minutes, and the detonator will not explode till nearly all the explosive has burned away and it comes in actual contact with the flame.

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The only way to explode roburite No. 3 is to detonate it by means of a cap containing at least one gramme of fulminate of mercury. These caps are never inserted into the cartridge except immediately before use, so that the roburite itself can be stored in any quantity with perfect impunity. Nevertheless, in England, owing to the existing Acts of Parliament, all substances called by the name of "explosives" are classed together and provided for, irrespective of their safety or any physical or chemical property, and the restrictions imposed seriously hamper the use of such as have proved to be perfectly harmless.

With a view to proving some of the assertions as to advantages made on the circular a number of experiments were conducted in the presence of the visitors. A weight of 59 lbs. was dropped from varying heights on to cartridges of various explosives. The weight was dropped from a height of about 15 inches on to a small quantity (about 1 oz.) of carbonite which resulted in an explosion; a similar experiment with gelignite gave a like result. The same weight was dropped from a height of *20 feet* on to roburite, which resulted only in a slight crack, such as resulted from a similar experiment with nitrate of ammonia, which of itself is a non-explosive substance. Further experiments were conducted, proving the advantage stated in (*c*); cartridges being formed half of dynamite and half of roburite. With respect to (*d*), three 2oz. cartridges of carbonite were placed 4 inches apart (side by side) and the centre one fired by a detonator; the other two cartridges exploded by sympathetic detonation. A similar experiment with roburite resulted in the two cartridges not containing a detonator being scattered but not exploded. This was clearly proved by the fact that only one depression was made in the ground in the latter case, where the roburite cartridge containing the detonator was fired, whereas in the experiment with carbonite cartridges the three depressions showed that all the cartridges exploded.

Mr. Biggwither stated as his opinion—as based on the results of such experiments—that the final conclusion of the Flameless Explosives Committee would not be correct in the case of explosives of the nitrate of ammonia class. The committee's conclusion referred to is that "In the case of a charge of a high explosive which has missed fire, if a short length of stemming (proved up to 8 inches) has been employed, the charge can be detonated by another cartridge of the explosive and additional stemming being placed in the hole in front of the original stemming." This conclusion was published in Part I. of committee's report; in Part III. it has been omitted.

An experiment was conducted on the lines stated in *e*, with the result stated. An electric detonator was inserted in a 4-oz. cartridge of roburite, which was then thrown into a brisk fire. The roburite burnt quietly away, after which there was an explosion, such as would be caused by a detonator alone.

Park Collieries, Lancashire.*

The No. 1 pit is 13 feet in diameter and 135 feet deep to the Wigan 9 feet mine; The Wigan 4 feet mine is also worked at this pit; the horizontal winding engine has two cylinders, each 16 inches in diameter and 3 feet stroke. The drum is 7 feet in diameter. The haulage is on the endlsss rope system, worked by an engine placed above ground. At the bottom of this pit is a double-acting pump (5 inches in diameter) which supplies the water to the slack-washer. The coal is passed over fixed screen bars, and is picked on travelling belts made of steel plates.

The No. 2 pit is 14½ feet in diameter and 954 feet deep to the Arley mine; The Orrell 5 feet or Rushy Park seam is also worked. The horizontal winding engine has two cylinders 26 inches in diameter and 4½ feet stroke. The drum is 16 feet in diameter. The haulage is on the endless-rope system, and is worked by a hauling engine on the surface. The coal is screened by "shakers," which separate the coal from each mine into three sizes.

The No. 3 pit is the upcast shaft for Nos. 1 and 2 pits; it is 14½ feet in diameter and 954 feet deep. The horizontal winding engine has two cylinders, each 18 inches in diameter and 3 feet stroke, fitted with drum 8 feet in diameter.

The mine is ventilated by a Walker fan, 24 feet in diameter, fitted with the V-shutter. The fan is driven by a horizontal compound condensing engine: the high-pressure cylinder 22 inches in diameter, the low-pressure cylinder 38 inches in diameter and 4 feet stroke. A pulley, 16 feet in diameter, on the engine shaft transmits the power by 15 cotton ropes to a pulley 7 feet in diameter on the shaft of the fan.

A Hall ventilation recorder is placed in the manager's office, and is connected with the fan drift.

The fan is capable of passing 300,000 cubic feet of air per minute at a water-gauge of 6 inches.

The hauling engine is compound and condensing, with high-pressure cylinders 20 inches in diameter, and low pressure cylinder 36 inches in diameter and 4 feet stroke. The two haulage ropes are carried on taper-tread pulleys on the third-motion shaft, which is geared down as 7 to 1. The rope pulleys are fitted with clutch arrangements, so that either rope can be thrown in or out of gear as required. Both ropes pass down the No. 3 pit.

In the boiler-house are four Lancashire boilers, each 30 feet long and 8 feet in diameter, blowing off steam at a pressure of 100 lbs. per square inch. At the back of the boiler-house is a Green economizer containing 256 pipes.

The slack-washer is of the trough type, and has a capacity of 200 tons per day.

There are carpenters' shops, wagon painting and repairing shop, smithy with a small steam hammer, stables, &c.

About 800 deflector safety lamps are in use.

* From paper written for the members of the North of England Institute of Engineers, on the occasion of their visit to Wigan.

The Midland Institute of Mining, Civil and Mechanical Engineers.

THE annual meeting of the Midland Institute of Mining, Civil and Mechanical Engineers was held at Barnsley on Wednesday, 22nd July. Mr. JOHN NEVIN, president, in the chair. The report and accounts were adopted and the officers for the ensuing year were declared:—President, Mr. G. Blake Walker, J.P.; vice-presidents, Messrs. A. A. Atkinson, E. W. Thirkell, and J. E. Chambers; council, Messrs. J. Longbotham, M. Hall, H. B. Nash, W. Henry Chambers, J. Mellors, J. R. R. Wilson, H. St. John Durnford, and Professor F. W. Hardwicke; secretary and treasurer, Mr. T. W. H. Mitchell.

THE CAUSES OF DEATH IN COLLIERY EXPLOSIONS.

Dr. JOHN HALDANE, M.A., Oxford, read a paper on the above subject, particulars of which we have previously published.

ELECTRIC COAL-CUTTING ON LONGWALL FACES.

Mr. T. B. A. CLARKE read a paper on this subject, in which he described a coal-cutting plant, three machines with the cutter wheel split into two parts segmentally, for cutting 480 linear yards, yards, producing 600 tons to 700 tons per day from a seam 3 feet thick. He advocated the use of a vertical high-speed engine for dynamo driving, recommended separate cables rather than concentric cables, advocated the disc wheel, split as above, rather than the cutter bar, of the Manchester or ironclad motor, and claimed for electricity, as compared with compressed air, an economy in the first cost of plant, and a large annual saving in addition.

The discussion was adjourned.

The annual dinner was held in the evening at the Queen's Hotel, Mr. G. BLAKE WALKER,, J.P., president-elect, in the chair.

THE CRISIS IN THE COAL TRADE.

The PRESIDENT, replying to the toast of "The Midland Institute," said the fact that the great majority of collieries were not only not making profits but were losing money heavily, was beginning to be recognised beyond dispute, but the special difficulty of the time arose from the attitude of labour, which had determined to maintain wages at a high level, and the great abundance of money seeking investment. The representatives of labour were determined that wages should be maintained at a level which did not leave the colliery owner any margin of profit, and the plethora of money furnished the means for adding greatly to the output, thus putting upon the market a large quantity of coal, which displaced to a great extent coal which would otherwise have been produced from the older collieries. There was also, as far as they were personally concerned, the more favourable position as regarded common markets in which their competitors in other districts were placed through their having obtained important reductions in wages. The cost of producing a ton of coal was made up of five principal items—the cost of labour, which might be taken at 73 per cent. of the whole; stores, fuel and materials which had to be purchased, 10 per cent,; royalty, 11 per cent.; cost of management and sale of the coal, 5 per cent.; rates and taxes, 1 per cent. In arriving at the selling price a deduction of 10 per cent. must be made for the coal used at the colliery, and for dirt sent out with the coal. Of the remaining 90 per cent., 40 to 45 per cent. would be large or round coal, 20 per cent. nuts, 25 to 30 per cent. slack, worth perhaps 2s. per ton. Take approximate current prices for Barnsley coal, and they got round coal, 42 per cent. at 7s.; nuts, 20 per cent. at 4s. 6d.; slack, 27½ per cent. at 2s.; colliery, 10 per cent., giving an average price of 4s. 9d. per ton. With a cost of 5s. 9d. per ton, there would be on such figures a loss of 9d. per ton, or for a colliery raising 300,000 tons, £11,200 a year. Compared with other districts, South Yorkshire was seriously handicapped in the cost of conveyance to the seaboard; and it was feeling very acutely the pressure of foreign competition. Their chief foreign rival was Germany, which in 1885 raised 58,320,400 tons, worth 15 million pounds; in 1890 raised 70,237,800 tons, worth 26½ million pounds; and in 1894 raised 76,741,100 tons, worth 25 million pounds. The competition of Germany in neutral markets was due not only to normal circumstances, but to the powerful trading combination which existed in that country, which embraced practically all the collieries, so that the syndicate did not suffer from competition amongst their members in their home market, and their surplus coal could be sold in competition with English coal in neutral markets at a positive loss, such loss being made good at the expense of the home consumer. It had been suggested they must have a similar syndicate in this country if the older collieries were to be saved, and employment found for those who worked in them; and notwithstanding varying conditions and prejudice, he believed the combination of collieries for the purpose of mutual defence would soon be recognised as inevitable in this country. They were in a transition state. In the coal trade the interests of capital and labour were so identical, each was so absolutely dependent upon the other, that a system in which labour should share with capital the fluctuations of supply and demand on a co-operative basis was bound to come within the sphere of practical politics before long, and as this could be done only on a large scale, an amalgamation of capitalist interests must precede it. Meantime it was a pity that an intelligent view of the true interests of the coal trade in their own locality

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should not be taken. It could not be good for the colliers in the district that the old collieries should be closed. The old fable of killing the goose which laid the golden eggs might well be meditated by those who controlled the interests of labour, and they could only hope they would be guided by a broad and wise appreciation of the economic circumstances of the time, and not by a passionate antagonism to those by whose capital the coal trade of the district had been founded and by which it still subsisted.

Competition Questions.

An award of 2s. 6d. will be made to the sender of the best answer to each of the questions given below. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered. Envelopes to be marked "COMPETITION," and to reach us before August 21st, 1896.

We invite readers to forward questions for this competition.

(1) How many lbs. of gunpowder will be necessary to drive a tunnel 50 yards long, 10 feet by 6 feet, 10 yards of which is in hard white rock and the rest moderately hard blue metal?

(2) Two seams of coal dipping one in three, the upper seam 2 feet 9 inches thick, and lower seam 3 feet 4 inches thick, vary in distance from 3 feet 6 inches to 9 feet apart. The roof over the top coal is strong black bass, the strata between the seams is strong warrant and fireclay, and the floor of the lower seam is strong fireclay. Describe, with sketches, the method you would adopt in working these seams.

(3) What is meant by having "the weight" on the coal, and what practical use is made of it? How is the weight increased or decreased?

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

(1) James Laverick, Butterknowle, County Durham.

(2) W. Slocombe, Thorne Avenue, Newbridge, Newport, Mon.

Commended.—T. Graham, Carron Colliery, Shield Hill, Falkirk, N.B.; J. C. Binks, Sandhill, Rawmarsh, Rotherham; W. Mitchell, Dalharco, Patna, Ayrshire, N.B.; T. E. Aitchison, Greenhill, Dunaskin, Ayrshire; S. Micklewaite, Horner House, Stocks Bridge, near Sheffield; Sam. Davies, Barrow Farm, Worsbro', near Barnsley; G. W. Hedley, Medomsley Edge, Medomsley, R.S.O., County Durham; J. Skipsey, 25, Co-operative Terrace, Newsham, Northumberland; R. W. Cuthbertson, Hartington House, Stavely, near Chesterfield; H. Hopper, Office House, Cambrian, Blyth, Northumberland; J. G. Bell, Evenwood, Bishop Auckland; J. H. Senior, 16, Thompson Row, High Street, Rawmarsh, Rotherham; G. Tweddell, 9, Lloyd Street, Lemington-on-Tyne; W. Sutherland, 108, Wigan Road, Hindley, near Wigan; S. Ware, 206, Pall Mall, Chorley; T. Wilkinson, Bracker Street, Over Hulton; R. Ankers, 471, St. Helens Road, Daubhill, Bolton; J. Bateman, Chapel Street, Audley, Staffordshire; W. Charnock, The Grove, Standish, near Wigan; Wm. Dickinson, Nettleworth Pit, Durham; J. Finch, Green Lane, Hindley Green, near Wigan; J. McKean, 11, Tyne Street, Wellington, Durham; G. Hopkins, Rhondda Terrace, Ferndale, Pontypridd; W. Ollerenshaw, 46, Grosvenor Street, Ashton-under-Lyne.

Moss Hall Coal Co., Ld., Maypole Sinkings, LANCASHIRE.*

The Maypole sinkings of the Moss Hall Coal Company, Limited, is a new winning and extension of their present coalfield in a southerly direction beyond a fault of 540 feet, the boundary of their present workings. This fault throws 480 feet of red sandstone into the present sinking shafts.

The works were commenced about fifteen months ago. They consist of a brickworks with drying sheds, kilns, and a plant capable of making 12,000 pressed bricks per day.

The No. 1 pit is sunk down and bricked to a depth of about 406 feet, and has about 90 feet further to go before it passes through the red rock.

At the present time 60,000 gallons of water per hour is being pumped by a Hathorn-Davey pumping engine of the bull type, with a steam cylinder 70 inches in diameter and 8 feet stroke and beam underneath. Coupled to this is a ram 24 inches in diameter and 10 feet stroke, with a steel rising-main 20 inches in diameter. There are two sets of spears, a spare set to be coupled up to another ram to pump to the present ram when the water-bearing strata is passed through. The present ram is pumping out of lodges at a depth of 348 feet,

A Pearn's pump is fixed at a depth of 348 feet, with two steam cylinders 24 inches in diameter, and rams 10 inches in diameter and 18 inches stroke.

Two Evans Cornish sinking pumps are slung from the surface; they have steam cylinders 24 inches in diameter, and rams 12 inches in diameter and 24 inches stroke; the slings consist of steel rods 3½ inches in diameter in 10 feet lengths, raised or lowered with a screw 5½ inches in diameter worked by two pairs of self-contained engines with steam cylinders 10 inches in diameter and 9 inches stroke, and all the connections are put on at the surface. The sinking to the present depth has been done with the sling pumps dealing with the water.

The winding engine for sinking this pit has two steam cylinders 24 inches in diameter fitted with Cornish valves and a drum 10 feet in diameter; they are geared 3½ to 1, and Elliot locked coil ropes are in use.

The No. 2 pit, 126 feet deep, is standing at present; it was sunk to this depth with a self-contained Dunlop engine. The permanent winding engine has two steam cylinders 33 inches in diameter and 6 feet stroke, fitted with Cornish valves; the drum is 15 feet in diameter. The further sinking of this shaft will be effected with these engines.

There are six double-flued Lancashire boilers 30 feet long and 8 feet in diameter, working at a pressure of 100 lbs. per square inch.

* From paper written for the members of the North of England Institute of Engineers, on the occasion of their visit to Wigan.

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Colliery Managers' Examination Questions.

Manchester and Ireland District, December, 1895.

FIRST-CLASS CERTIFICATES OF COMPETENCY.

The numbers in parenthesis denote the marks given for each question.

PART I.—Time allowed, 11 a.m. to 1 p.m.

I.—Arithmetic.

1. What is the diameter of a pump which will deliver as much water in 10 hours as a 10-inch diameter pump will deliver in 15 hours, both working at the same speed? (3)

2. A pipe is 9 feet long and 8 inches internal diameter. How many gallons of water will it contain at 277·274 cubic inches to the gallon? (3)

3. A drift or tunnel is 75 yards long, 7 feet wide at the top, 9 feet wide at the bottom, and 7 feet 6 inches high:—

(*a*) What would be the cost per cubic yard of the tunnel if the price was £3 per lineal yard?

(*b*) How many tubs or boxes of 15 cubic feet capacity would be filled out of the tunnel if the proportion of solid to the broken as 55 is to 114? (3)

II.—C.M.R.A. and Special Rules.

1. What are the requirements of the Coal Mines Act as to the construction and position of furnaces and fans? (4)

2. Give shortly the General Rules with regard to lamp stations. (4)

3. State what you know of the Registers to be kept in or about a mine. (4)

4. What safeguards are specified by the General Rules as precautions against accidents during winding, caused by mistakes of the engineman or defects in the working of the engine? (4)

5. What are a manager's duties as defined by the Special Rules of this district with respect to the use of explosives and the precautions to be taken? (4)

6. What rules refer to the catches or knees under cages at the pit top? Give the words of the rules as near as you can, and state also the duties of the banksman in connection with the same. (4)

PART II.—Time allowed, 1-30 p.m. to 5-30 p.m.

III.—Practical Mechanics.

1. A pair of winding engines have cylinders 30 inches in diameter, and a stroke of 5 feet, and the steam pressure is 60 lbs. per square inch. What is the greatest diameter the drum can be made in order that the engines may be able to lift a load of five tons, allowing a margin of one-third for overcoming friction? (6)

2. Give particulars of all the fittings which should be applied to a Lancashire (two-flued) boiler, 30 feet long, 8 feet diameter, and carrying a pressure of 80 lbs. per square inch. Also give the thickness of the steel plates you would use in the shell and flues. (6)

3. A vertical column of cast-iron pipes is 220 yards high, the bottom length of 50 yards is 8 inches internal diameter, and the remainder 10 inches. What is the total pressure on the bottom of the column when the pipes are full of water? And what is the weight resting on the bearers (including the pipes and the water), assuming the average thickness of the metal in the pipes to be 1 inch? (6)

4. Sketch either a brake-jig and frame, as fixed, or the return pulley, as fixed, of an endless rope haulage system, and give the leading dimensions. (6)

IV.—Practical Working of Collieries.

1. If a large district of coal workings became fouled with fire-damp, how would you proceed to ascertain the cause, and also how would you proceed to clear the gas from the workings? What materials would you require, and what precautions would you take in order to provide for the safety of those employed in the work? (6)

2. If you had endless rope drawing coal up an incline and working by means of a clutch pulley, what precautions would you adopt against accidents in the event of the rope breaking and of the pulley being thrown out of gear? (6)

3. Which do you consider to be the best system of working a coal seam which is liable to spontaneous combustion—longwall or pillar and stall? Give your reasons in full (6)

4. Two seams of coal dipping one in three, the upper seam 2 feet 9 inches thick, and lower seam 3 feet 4 inches thick, vary in distance from 3 feet 6 inches to 9 feet apart. The roof over the top coal is strong black bass, the strata between the seams is strong warrant and fireclay, and the floor of the lower seam is strong fireclay. Describe, with sketches, the method you would adopt in working these seams. (6)

5. Describe fully, with sketches, the method you would adopt to ventilate a sinking pit when firedamp is given off freely from the measures (strata). (6)

6. If a shot-lighter finds the coal holed 3 feet at the bottom, and cut 3 feet at the sides, and the drill hole is 3 feet 3 inches deep, what course ought he to take? (6)

V.—Mine Gases, Lighting, and Ventilation.

1. A fan, 24 feet in diameter, is running at 98 revolutions per minute, and gives 290,000 cubic feet of air per minute in the fan drift, with a water-gauge of 4 inches. The indicated horse-power of the engine is 238·5. What is the horse-power in the air, and what is the percentage of useful effect? (4)

2. How much fire-damp would have to be given off to foul a current of 6,000 cubic feet of fresh air per minute, sufficiently to allow the presence of the gas to be detected by the flame of a safety lamp? Without more than thus fouling the current, what is the shortest time in which it would be possible to remove a body of undiluted gas entirely filling a pair of brows, each 100 yards long, with four cut-throughs, each 20 yards long, both brows and cut-throughs being 5 feet high and 8 feet wide? (4)

3. When fire-damp, at its most explosive point, is fired, what takes place? What are the resultant gases, in what proportions, and what are their properties? (4)

4. Describe a method or methods of testing for small percentages of fire-damp such that the presence of the gas cannot be detected by means of an ordinary safety lamp. (4)

5. Describe and give sketches of an air crossing suitable for passing over or under a main haulage road. The crossing to be proof against damage by explosion. (4)

6. Show how to ventilate the workings shown on the accompanying plan without using any air doors except those shown. Drawing roads are distinguished by dotted lines. (7)

Oral Examination, 15. Total number of marks, 132.

Candidates must obtain at least 40 per cent. of the marks given in each subject. Two-thirds of the total number of marks are required for a pass.

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SECOND-CLASS CERTIFICATES OF COMPETENCY, DECEMBER, 1895.

PART I.—Time allowed, 11 a.m. to 1 p.m.

I.—Arithmetic.

1. A pit tub is 3 feet 4 inches long, 2 feet 10 inches wide, and 1 foot 8 inches deep. How many cubic inches and how many cubic feet does it contain? (3)

2. Add twenty-five pounds and threepence to £195 18s. 6½d.; multiply the result by twenty-six, and subtract one thousand and eighteen pounds thirteen shillings and ninepence. (3)

3. What weight of steel girders, placed as bars, would be required to secure a road 80 yards in length, the girders each being 7 feet long, and weighing 60 lbs. to the yard, and placed at an average distance of 4 feet apart? (3)

4. A collier's wage is 4s. 8d. per day, and he works 5 days per week. How much does he earn in a month of four weeks? If he suffers a reduction of 12½ per cent., how much will he then earn per day and per month? (3)

II.—Coal Mines Regulation Act, 1887, and Special Rules of the District of North and East Lancashire and Ireland.

1. What are the provisions of the Coal Mines Regulation Act as to fencing? (4)

2. If you have an accumulation of firedamp in a mine, what precautions as to its removal are required to be taken under the Mines Act and Special Rules? (4)

3. Enumerate the duties of an engineman as specified in the general and Special Rules. (4)

4. If a collier neglects to sprag the coal whilst he is engaged in holing, what are the steps to be taken by the under-manager in dealing with him? (4)

5. What are the under-manager's duties in the case of an accident occurring to a work-person under-ground? (4)

6. What are the duties placed upon a fireman by the Special Rules with respect to doors, brattices, and stoppings? (4)

PART II.—Time allowed, 1-30 p.m. to 5-30 p.m.

III.—Practical Working of Mines.

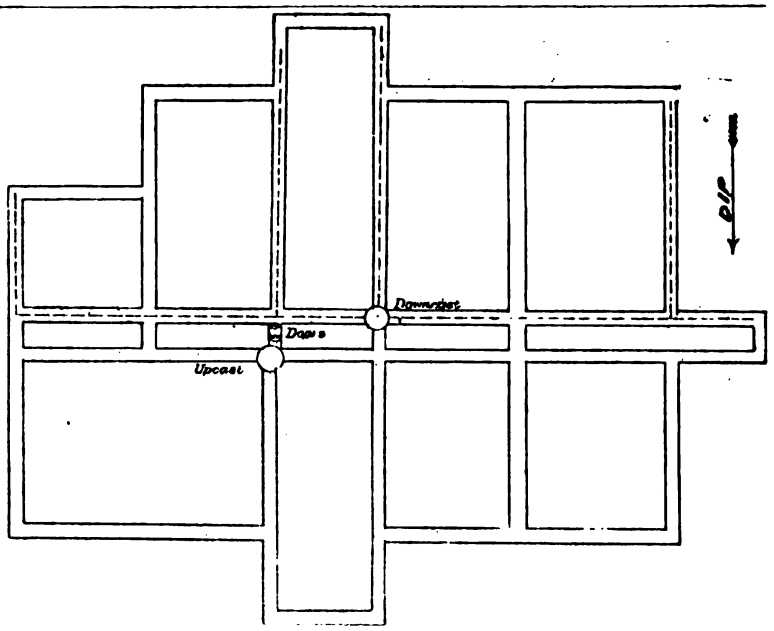
1. What do you consider to be the best mode of signalling along levels and inclines? State the relative advantages or disadvantages of electric signalling, and of any other system you are acquainted with. (6)

2. What are the special dangers in working steep mines over those of flat seams? Describe the precautions you would adopt to guard against these special dangers. (6)

3. If a fault is met with in driving a level, which throws all the coal out, how do you know whether the coal is thrown up or down? If it is thrown up, in what direction would you drive to find the coal, supposing the dip of the mine to be 1 in 6 to the south? (6)

4. What course would you take in lighting a number of shots when the men are out of the pit, and why? (6)

5. Describe, with sketches, the way in which you would set up a door in a waggon road so that it would close itself. (6)



6. Describe the method of laying a bricking ring in metal, and also in hard rock in sinking a pit. What precautions should be taken when sinking below the ring? (6)

IV.—Mine Gases, Lighting, and Ventilation.

1. What proportion of firedamp and atmospheric air constitutes the most explosive mixture? At what proportions does the mixture cease to be explosive? (4)

2. What gases are met with in coal mines? Give their names, and place them in the order of their weights. (4)

3. Which, in your opinion, is the best construction of safety lamp? State your reasons. (4)

4. If you unexpectedly found yourself in an explosive atmosphere, what would you do? If in black damp, what would you do? (4)

5. What quantity of air is passing through a road 7 feet 6 inches wide by 5 feet 9 inches high, when the velocity is 475 feet per minute? If the velocity were doubled, how would this affect the friction upon the sides of the road? (4)

6. Show how to ventilate the workings shown on the accompanying plan without using any air-doors except those shown. Drawing roads are distinguished by dotted lines. (7)

Oral Examination, 18. Total number of marks, 117.

Candidates must obtain at least 40 per cent. of the marks given in each subject. Two-thirds of the total number of marks are required for a pass.

EXTENSION OF THE WARWICKSHIRE COALFIELD.—It is stated that the sinking operations which have been carried on for some time past by the Hockley Hall Whateley Collieries and Brickworks Co., Ltd., at Kingsbury, have resulted at a depth of 208 yards in reaching two seams of coal, known as the Rider and Bare. The two seams at this point run together and practically form one seam, being divided by only two inches of parting. The coal is said to be of excellent quality and it is proposed to raise an output of 2,000 tons per day. The royalty is some 2,000 acres in extent and is owned by Sir Robert Peel. This colliery is considerably further to the westward than any other sinking as yet attempted in the Warwickshire coalfield.

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Answers to Competition Questions.

GIVEN IN No. 16, VOL. IV.

ANTHRACITE AND WHERE FOUND.

(1) What is anthracite and where is it principally found?

Answer.—Anthracite coal is somewhat difficult to describe on account of its variations in quality. Anthracite proper is shiny and bright in appearance, and is hard and brittle. It is difficult to light, but when burning develops great heat, especially when a strong draught is applied to it. It decrepitates in burning, and this property is believed to be due to the presence of water between the fibres of the coal; this water being heated is converted into steam, thus splitting up the coal. No smoke is emitted from its combustion. It does not soil the fingers on being handled, and is further distinguished by its high specific gravity and large proportion of carbon (from 90 to 95 per cent.), whilst it has a low percentage of sulphur and ash. Anthracite is a coal from which the bituminous parts have been eliminated. It occurs in beds like ordinary coal, but in positions where probably it has been subjected to some change whereby its volatile constituents have been expelled.

Chemical composition (South Wales):—

Carbon	90·39	per cent.
Hydrogen	3·28	,,
Oxygen	2·98	,,
Nitrogen	0·83	,,
Ash	1·61	,,
Sulphur	0·91	,,
	100·00	,,

Anthracite is found in Scotland and Ireland. The deposits in these places are limited and poor in quality, but those in South Wales are largely developed. It is also very largely developed in the great coalfield of Pennsylvania, U.S.A.

Anthracite is sometimes called "stone coal;" in Scotland "blind coal," and in Ireland it is known as "Kilkenny coal. JAS. LAVERICK.

NATURAL SYSTEMS OF DIVISION IN COAL SEAMS.

(2) What natural systems of division are found in coal seams, and how does their position affect the working?

Answer.—A seam of coal rarely consists of pure coal from top to bottom. There are generally two or more layers, which vary in composition, hardness, and thickness. One part may be of excellent quality and another of inferior quality. The seam is sometimes divided by bands of black shale, fireclay, etc., interfering very much with the working of the seam and the cleaning of the coal to render it fit for the market. Then we have embedded in the coal iron pyrites, or bisulphide of iron, more generally termed "brass," which is sometimes found in small pieces and sometimes in thin layers; when mixed with coal in heaps it is liable to spontaneous combustion. The above-mentioned bands are what I take to be the natural systems of division in coal seams. These bands or beds of shale, etc., were deposited during the formation of the coal. Storms and tempests would take place then, as now, and would carry along the running waters sand and mud and deposit them upon the vegetable matter, and again the vegetation would be deposited upon the mud or sand and thus form a natural division.

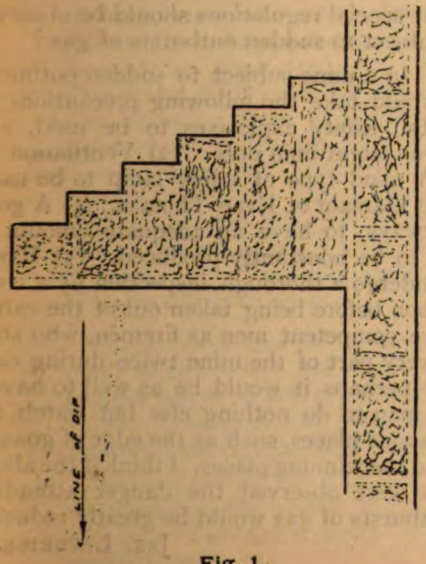

Fig. 1.

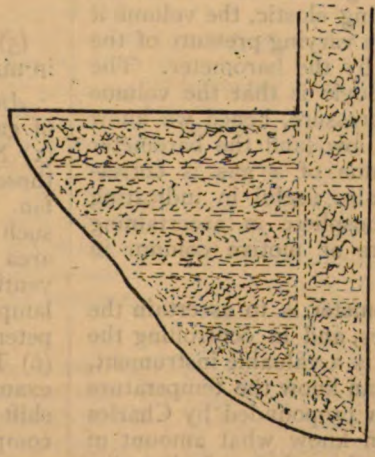

Fig. 2.

As to how these divisions affect the working of a coal seam depends upon the thickness and nature of the partings, but in all cases they make the coal much worse to dig and reduce the market value. Often when these bands are six inches or more in thickness they are better adapted for longwall working.

JAS. LAVERICK.

[We consider this question to have reference more particularly to the cleavage.—Ed.]

LONGWALL WORKING.

(3) What is longwall working and how is it applied (*a*) in a flat seam and (*b*) in one with a high dip?

Answer.—By longwall working is meant the operation of taking out the whole of a

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coal seam in one working as the face advances. After the shaft pillars are left behind the mine is divided into districts, and each district is kept as far as possible on one face and the roadways are kept through the gob and supported by packs of rubbish, cogs, etc. By these means no pillars of coal are left behind to be crushed into slack, and as less cutting up of the seam is required less slack is made in the working.

(*a*) In a flat seam there are many modifications, but it is generally applied by levels driven at right angles to the line of cleavage. The headways are turned away off the levels at a suitable angle, and the stalls are worked off the headways parallel with the levels. In some cases the stalls are from 12 to 18 yards apart, while in others they are from 40 to 60 yards apart, and the roadway continued along the working face, forming what are called "Nottinghams."

(*b*) In a seam with a high dip it is generally applied by driving the opening levels to the full rise and dip and opening the headways on the line of strike, always working the stalls to the rise. In this way the coal can be jigged to the level headways, and on the rise side can be jigged to the shaft. (Figs. 1 and 2 show the outlines of the two methods.) WM. SLOCOMBE.

THE USES OF THE BAROMETER, THERMOMETER, ANEMOMETER, AND WATER-GAUGE.

(4) Explain the uses of the barometer, thermometer, anemometer, and water-gauge in controlling the ventilation of mines.

Answer.—The use of the barometer is to measure the weight or pressure of the atmosphere and to tell the variations of that pressure. Air and gas in goaves and old workings exist as a free and disengaged body, and being elastic, the volume it occupies is subject to the varying pressure of the atmosphere as indicated by the barometer. The law as propounded by Boyle is that the volume varies inversely as the pressure, hence we know that when the pressure is low (and the barometer indicates this) the volume of a gas is correspondingly high. It is also useful in indicating the pressure of the atmosphere in ascertaining the difference in pressure or motive column in ventilation.

The use of the thermometer is to ascertain the differences in temperatures, and in controlling the ventilation of a mine it is a valuable instrument, as by its application we can know the temperature of the air, and by the law propounded by Charles and Guy Lussac we can know what amount of contraction or expansion takes place. It is indispensable in furnace ventilation in ascertaining the motive column or pressure producing ventilation, as to know this we must know the temperature of the air in both columns.

The use of the anemometer is to determine the speed or velocity of air-currents. To know the quantity of air which passes through an airway in a given time we must know its speed for that time, and by setting up the anemometer in the path of the current and letting it run for the given time we have the speed registered on the instrument for that time. Then by multiplying the speed by the section of the airway, both being expressed in the same term, we have the cubic contents of the air which has passed in the given time. Thus, if the time be one minute, the section 36 square feet, and the velocity 500 feet, the quantity would equal $500 \times 36 = 18{,}000$ cubic feet per minute.

The water-gauge is used for measuring the pressure producing ventilation, generally expressed in lbs. per square foot, and also for determining the frictional resistance which the air meets with in its passage round the workings. When a fan works, or a furnace is applied at an upcast, the object aimed at is to create a difference in pressure between the upcast and downcast, or intake and return, and the water-gauge measures this difference and enables us to know the useful work obtained in ventilation from the power expended to produce it, thus giving us the useful effect of our ventilating apparatus. With fan ventilation a water-gauge is placed in the engine-room, one end being connected to the fan-drift and the other to the open atmosphere, and it is generally the duty of the engineman in charge to regulate the speed of the fan according to the barometrical reading, so as to maintain a uniform water-gauge. WM. SLOCOMBE.

SPECIAL REGULATIONS IN MINES SUBJECT TO SUDDEN OUTBURSTS OF GAS.

(5) What special regulations should be observed in mines subject to sudden outbursts of gas?

Answer.—In a mine subject to sudden outbursts of gas I would take the following precautions:—(1) None but safety explosives to be used, and those by competent men only. (2) Ventilation by fan. (3) A good type of safety lamp to be used, such as the Marsaut or Evan Thomas. (4) A good area of airways, to have an adequate amount of ventilation to be constantly produced. (5) Every lamp to undergo a thorough inspection by a competent person before being taken out of the cabin. (6) To have competent men as firemen, who shall examine every part of the mine twice during each shift; and perhaps it would be as well to have a competent man to do nothing else but watch the most dangerous places, such as the edge of goaves, hitches, and the winning places. I think if the above regulations were observed the danger attending sudden outbursts of gas would be greatly reduced.

JAS. LAVERICK.

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Examination Questions with Answers.

By JOSEPH CARTER, First-class Certificated Manager.

Questions given at the Examination for Certificates of Competency for the West Lancashire & N. Wales District, June, 1895, at Wigan.

FIRST-CLASS.

Continued from No. 17, Vol. IV.

Principles of Mechanics and Machinery.

QUES. 6.—How often would you examine a steam boiler internally, and what are the points to be noted?

ANS.—I should have a steam boiler examined internally once every month. In addition to this I should have an examination made by an expert once every 12 months of each boiler, and this should be a thorough examination, *i.e.*, both internally and externally. In making an internal examination, the points which I should note are:—(1) The accumulation of scale on the plates. As this prevents an examination of the condition of the plates to be made, besides being a bad conductor of heat, it prevents the heat being taken up readily by the water, and as a consequence is liable to cause such overheating of the plates as to make them unfit for the pressure they have to sustain. (2) Internal corrosion. (*a*) It also occurs in the form of blotches, that is plates thinned more or less over various parts of their surface, whilst other portions of the plates remain unimpaired. (*b*) Another kind, and this is I have no doubt the commonest form of corrosion, is known as "pitting." The plates so affected have the appearance of a face having been ravaged by small-pox. (3) Internal grooving. This defect is induced by expansion and contraction, resulting from variations of temperature of pressure, yet it develops all the more rapidly when the feed-water is of a corrosive nature. This defect is more liable to be found about the crown-plates of the flue tube, also round the root of the angle-iron or flanges by which the end-plates are attached to shells, as well as about the narrow water spaces of internally fired boilers.

QUES. 7.—Describe in detail such a winding plant as you would put down to draw 600 tons of coal per day of 10 hours, winding from a depth of 500 yards. Give principal dimensions of the requisite engines, boilers, and other plant.

ANS.—In order to find size of engines required we must find the weight to be lifted, therefore we will say that eight hours is occupied only for winding coal.

600 tons in 8 hours $= \frac{600}{8} = 75$ tons per hour

and $\frac{75}{60} = 1{\cdot}25$ tons per minute.

Take speed of cage at $33\frac{1}{3}$ feet per second, and we have $\frac{1500}{33\frac{1}{3}} = 45$ seconds time of actual winding for each wind; say 15 seconds will be taken up in changing cages, and we have 1·25 tons of coal coming to the surface every minute.

Weight of coal	25	cwt.
,, boxes	10	,,
,, cage	25	,,
	60	,, load.

This would require a rope with a breaking strain of about 30 tons, but as the weight of the rope has to be added, breaking strain would have to be about 45 tons. In this case the rope will be 250 fathoms of best plough steel, weighing about 12·5 lbs. per fathom, whose circumference would be $\sqrt{12{\cdot}5} = 3{\cdot}5$ inches; therefore the load on the engine would be as follows:—

Cage, chain, coal and boxes	= 6720	lbs.
Rope, 250 × 12·5	= 3125	,,
Load on engine	9845	,,

In this case I should have two cages in the shaft, therefore the cages and boxes would balance each other, so that on the engine would be weight of coal and rope—

∴ Weight of coal	2800	lbs.
,, rope	3125	,,
	5925	
To this add ½ for friction.....	2963	
	8888	

The diameter of cylinder can be found by the following formulæ:—$3\sqrt{\frac{L}{P}}$ L = load. P = pressure, in this case say 80 lbs.

$\therefore 3 \times \sqrt{\frac{8888}{80}} = 10{\cdot}5 \times 3 = 31{\cdot}5$, say 33-inch cyl.

So that the proportion of engine would be cylinder 33 inches diameter, 5 feet 6 inches stroke. The drum should be three times the length of the stroke, equals 16 feet 6 inches diameter.

Summary of what would be required—a pair of coupled horizontal winding engines, 33-inch cylinders, 5ft. 6in. stroke, and 16ft. 6in. drum; four Lancashire boilers, 30 feet by 8 feet, working at 80 lbs. pressure per square inch; other plant would be a capstan engine, in case of breakdown and repairs having to be done; fan capable of producing from 100,000 to 250,000 cubic feet of air; tipplers, two in number, would suffice, and two shoots to pass the coals on to two shaking screens, and for this a small engine would be required.

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QUES. 8.—Describe what in your opinion would be the most economical method of raising 200,000 gallons of water per 24 hours from a depth of 300yds.

ANS.—The most economical method to raise the water would be to place a pump underground, as the engine would be nearer its work, which is a great advantage. I should have plenty of lodge room for the water, in case of accident to the engine or pump, so that water would be several days before coming in the road. I should also in addition to this have a pump that would raise 200,000 gallons in 16 hours, leaving 8 hours for repairs and other stoppages.

The following calculations will show how to find the size of engine and pump capable of dealing with the above quantity of water :—

1. Find useful work to be done.

$$\frac{200,000}{16} = 12,500 \text{ gallons per hour.}$$

$$\frac{12,500}{60} = 208\tfrac{1}{3} \text{ gallons per minute.}$$

One gallon of water = 10 lbs.

$\therefore 208\frac{1}{3} \times 10 = 2,083$ lbs. $\times$ 900 = 1,874,700 units of work.

$$\text{H.P.} = \frac{1,874,700}{33,000} = 56{\cdot}8. \text{ Useful work.}$$

2. Find diameter of pump; say pump works at 120 feet minute.

$\frac{208\frac{1}{3}}{60} = 3{\cdot}5$ gallons per foot (60 is half-speed for single acting engine).

$3{\cdot}5 \times 277{\cdot}274 = 970{\cdot}459$ cubic inches.

$970{\cdot}459 \div 12 = 81$ square inches.

$\sqrt{81} = 9$ diameter Allow 20 % for slip and area of rod $= 9 + \frac{1}{8} = 10{\cdot}8$, say 11 inches diameter of pump.

$$\text{Pressure on pump} = \frac{900 \times 15}{34} = 397 \text{ lbs. per square inch.}$$

Say steam pressure is 60 lbs.

Total pressure on pump $= 397 \times 81 = 32,157$ lbs.

$$\text{Piston area} = \frac{32,157}{60} = 536 \text{ nearly.}$$

Add $\frac{1}{2}$ for friction $= 536 \times \frac{1}{2} = 804$ piston area.

$$\text{Diameter of cylinder} = \sqrt{\frac{804}{{\cdot}7854}} = 32 \text{ inches.}$$

Summary of engine required :—Diameter of cylinder, 32 inches, 5 feet stroke; steam pressure, 60 lbs.; diameter of pump, 11 inches; useful work, 56·8 horse-power.

North of England Institute of Mining and Mechanical Engineers.

THE Annual General Meeting of the Members of this Institute was held in the Wood Memorial Hall, Newcastle-on-Tyne, on Saturday, August 1st, under the Presidency of Mr. Thomas Douglas.

The Secretary (Mr. M. Walton Brown) read the Annual report of the Council, which referred in congratulatory terms to the increase of membership, the total number of the various classes of members having risen since 1894 from 813 to 1,046. The formation of the class of Association, consisting of members occupying subordinate positions in engineering, had been very successful and had tended to increase the membership roll; the recently initiated meetings of Students had also proved successful. During the year 264 bound volumes and 234 pamphlets, reports, &c., had been added to the library which now contained 7,178 volumes and 1,261 unbound pamphlets. A card catalogue of the library had been completed and rendered the books more accessible to members. The report of the Committee on Mechanical Ventilators was now completed and would be issued to members during the course of the next few months; five volumes of the Sinkings and Borings (Collieries A. to T.) had been issued and the remaining volumes would be issued at early dates. The Explosives Committee had concluded their investigations, and the results of their experiments and their recommendations were contained in the report recently issued to the Members. The Council had been in communication with the Secretary of State for the Home Department, as to the disposal of the plant, continuation of the experiments, etc., but the matter was still pending. The Council felt that the services which Mr. A. C. Kayll had rendered to the Explosives Committee in preparing the report, etc., deserved special recognition, and they had accordingly presented him with a gold watch and chain and cheque, as a token of the appreciation of the members. The Council were endeavouring to make arrangements in order that papers of interest to Indian and Colonial members might be locally read and discussed, and it was especially desired that members would endeavour to ensure the success of these localized meetings. Mr. A. R. Sawyer had called two meetings in Johannesburg; but owing to concurrent disturbances no definite arrangements were made for their being continued. After referring to the connection of the Institute with the Federated Institution of Mining Engineers, the report concludes with a list of papers communicated to the members during the year and of the prizes awarded to various Authors. The report of the Finance Committee showed the Institute to be in a very satisfactory financial condition. The sum of £1,850 has been invested during the year.

The President moved the adoption of the reports and referred to the fact that the membership now exceeded that of any previous year; he trusted that it would continue to increase and that the usefulness of the Institute would become more extended. He would particularly like to see additions to the number of Associates, for those

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who occupied subordinate positions in mines would often be able to give valuable information on matters which came under their notice. The subjects discussed during the year were very varied and dealt with the various scientific aspects of mining; the question of coal dust explosives had occupied a good deal of attention and still more information was desired before there would be unanimity of opinion in regard to it. Undoubtedly, in future accidents, much closer investigation would be required into the causes of death. The nature of gases given off by explosions had been the subject of an important paper recently issued by Dr. Haldane, and drew attention to a matter which was to a great extent new to most of them. The subject of electricity too, had been considerably discussed and no doubt electrical transmission of power had an important future in mining operations when they were satisfied that it could be safely adopted without the risk of sparks. Mr. J. B. Simpson seconded the adoption of the reports, which was unanimously agreed to.

The following gentlemen were elected to represent the Institute on the Council of the Federated Institution of Mining Engineers:—Mr. Henry Ayton, Mr. E. Bainbridge, Sir Lothian Bell, Bart., Mr. T. W. Benson, Mr. W. C. Blackett, Sir B. C. Browne, Mr. W. Cochrane, Mr. J. R. Crone, Mr. J. Daglish, Mr. T. Douglas, Mr. T. E. Forster, Mr. W. Galloway, Mr. J. Head, Mr. J. L. Hedley, Mr. A. C. Kayll, Mr. C. C. Leach, Sir W. T. Lewis, Bart., Mr. James McMurtrie, Mr. G. May, Mr. J. H. Merivale, Mr. H. Palmer, Mr. T. O. Robson, Mr. J. B. Simpson, Mr. A. L. Steavenson, Mr. L. Wood, Mr. W. O. Wood.

The following gentlemen were elected as the officers of the Institute for the ensuing year:—*President:* Mr. George May. *Vice-Presidents:* W. Armstrong, senr., C. Berkley, T. W. Benson, Sir W. T. Lewis, J. G. Weeks, W. O. Wood. *Council:* H. Armstrong, W. Armstrong, junr., T. W. Asquith, H. Ayton, W. C. Blackett, J. R. Crone, T. E. Forster, T. Y. Greener, A. C. Kayll, C. C. Leach, J. H. Merivale, J. Morison, H. Palmer, M. W. Parrington, A. M. Potter, R. Robinson, T. O. Robson, R. L. Weeks.

SAFETY EXPLOSIVES.

Bergassessor Winkhaus communicated a paper on some further experiments which had been conducted in Westphalia to determine the relative degree of safety of the more recently introduced high explosives. Two methods presented themselves by which these comparative values could be obtained: one was to increase the charges until ignition ensued, and the other to make the conditions of the experiments more severe by experimenting in atmospheres containing higher percentages of firedamp. The cannon employed was not adequate for the first method and the second was therefore selected, the experiments being continued up to the most explosive and most easily ignited gaseous mixture with 9 per cent. of firedamp. The mode of conducting the experiments and the arrangement of the apparatus corresponded exactly with those of the previous experiments. In this series of experiments gelatine-dynamit (which is not a safety explosive) was included with the following:—Cologne-Rottweiller blasting powder, Dahmenit A, Neu-westfalit, Roburit 1, and Kohlen-carbonit. As the result of experiments with coal dust in the absence of firedamp, it was shown that no ignition of the dust could be produced, even when the original cartridges, packed in paraffin envelopes, were employed. In explosive mixtures of firedamp, containing 6 to 6½ per cent. of methane, only Cologne-Rottweiller blasting powder gave an ignition; in 7 per cent. Cologne-Rottweiller and Dahmenit A.; and in 8 per cent. all the explosives with the exception of Kohlen-carbonit. In this latter experiment the following were the weights of the charges which ignited the mixture:—

	Ounces.	Grammes.
Gelatine-dynamit ...	1·23 or	35
Cologne-Rottweiller...	7·05 or	200
Dahmenit A.....	14·11 or	400
Neu-Westfalit	14·11 or	400
Roburit 1	17·63 or	500

Kohlen-carbonit was tried in charges of 21·16 ounces (600 grammes) without producing ignition. Gaseous mixtures with 9 per cent. of firedamp were ignited by the following minimum charges:—

	Ounces.	Grammes.
Gelatine-dynamit ...	0·35 or	10
Cologne-Rottweiller...	1·76 or	50
Dahmenit A.....	3·53 or	100
Neu-Westfalit	5·29 or	150
Roburit 1	8·82 or	250

Kohlen-carbonit was safe, even under these conditions, in charges of 21·16 ounces or 600 grammes, and was thus the only explosive which resisted all the conditions of these experiments. The experiments confirmed the previously determined fact that in the case of safety explosives of a very high degree of safety, the envelope of the cartridge, saturated with paraffin or ceresin, ceases to have any influence on the danger of ignition. Experiments with detonators were also repeated in large numbers, and the Bornhardt detonators were used in all the experiments with explosives, this detonator having withstood 45 tests in 9 per cent. fire damp mixtures without producing a single ignition. Experiments were also made on the explosives stemmed with various kinds of stemming and the results are shown in the extensive tables which accompany the paper. It was also demonstrated that water-tamping considerably increases the safety of an explosive.

Discussion on the paper was postponed and the usual votes of thanks terminated the meeting.

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Editorial Notes.

COLLIERY EXTENSIONS IN LANCASHIRE.—A number of new pits are now being sunk in Lancashire which will in a few years open up a considerable area of coal and will find employment for a large number of men. Messrs. A. Knowles & Sons are sinking a shaft near their existing Agecroft Colliery, Pendlebury, to a trencherbone seam 750 yards deep. Messrs. Roscoe & Sons are opening out a new mine at Little Hulton, near Bolton, and the Astley and Tyldesley Coal Co. one at Astley. The Moss Hall Co. are sinking at Bickershaw, near Wigan, particulars of which are given in the present number, and the Bold Hall Estate Co. are sinking at Bold, near St. Helens Junction. At the latter sinking, one shaft, 20 feet diameter in the clear, has been sunk to a depth of about 50 yards. These shafts are to be sunk some 700 yards, and if they are carried down to the lower seams will be some of the deepest in the kingdom. A considerable area of coal lies to the deep of the shafts which there will in all probability be a chance of reaching, and perhaps exceeding, the 4,000 feet limit fixed by the Royal Commissioners. The deepest shaft yet sunk in this country is at Ashton Moss Colliery, Audenshaw, which is 960 yards deep; some of the workings extend to a depth of 3,600 feet from the surface.

COLLIERY MANAGERS' EXAMINATION.—The annual examination was held at Leeds on the 23rd June and following days. There were 65 candidates in the first class, 24 of whom were successful, and 79 in the second class, of whom 42 passed. The names of the successful candidates for first-class certificates are as follows:—H. Robertshaw, J. W. Halmshaw, B. Browitt, S. Blackburn, H. Walsworth, J. Bingley, W. Soar, H. G. Townsend, G. B. Stone, W. Eastwood, W. H. Teasdale, J. Fisher, A. Fisher, W. F. Collins, G. Daykin, R. G. Drinnan, E. Isaac, S. Mellor, A. Wilson, F. H. Waterhouse, J. Crompton, W. H. Dyson, J. Jaggar, and J. Smethurst.

THE GERMAN COAL TRADE.—A despatch has been received at the Foreign Office from Berlin, in which it is reported that the consumption of coal in Germany has increased since 1890 from 90 to 100 million tons, and the production from 89 to 98 millions. Of the total imports of hard coal (over 5 millions) in 1895, nearly 4 millions came from England. The total export of German coal was over 10 million tons, which were sent to Belgium, France, Holland, Austria, Russia, and Switzerland. The import of foreign coal amounted to over 5 million tons, of which nearly 4 millions came from England and the remainder from Belgium and Austria. Austria also imported into Germany 7 million tons of soft coal. In April last the average price of lump coal in Lower Silesia was 12·6 marks; in Westphalia, 9 00 marks. The average price of English coal at Danzig, off ship, was 13·3 marks. A general rise of from 25 to 50 per cent. per ton in German coal is anticipated.

THE SPANISH MINERAL STATISTICS FOR 1895.—The Spanish Government has just published the mineral statistics of that country for the past year. The coal production amounted to 1,739,075 tons. There were 634 collieries in operation, employing 15,530 miners and 127 steam engines, aggregating 3,650 horse-power. There were also 56 lignite mines producing 44,708 tons and employing 657 miners, and one anthracite mine at which 7 miners produced 10 tons. Of iron ore no less than 5,514,339 tons were produced, 13,281 miners being employed, and of manganese ore 10,162 tons were obtained. The metallurgical products were pig iron 179,752 tons; wrought-iron 48,462, steel 56,801, coke 349,058, patent fuel 342,985. There were 16 iron and steel works, employing 8,517 workmen, 28 hydraulic engines aggregating 1,285 horse-power, and 304 steam engines aggregating 23,340 horse-power.

THE COAL-BORING IN EAST ANGLIA.—At the second ordinary general meeting of the Eastern Counties' Coal-Boring and Development Association, Limited, held at the Town Hall, Ipswich, under the presidency of the chairman of the directors, Mr. R. C. Rapier, the secretary, Mr. George F. Mansell, submitted the report and accounts which were taken as read. The report reminded the shareholders that when the last report was circulated the Stutton boring was in process and had gone down 938 feet. The boring was continued to the total depth of 1525 feet, but no signs of coal or other mineral were discovered in the strata pierced. The last 581 feet were palaeozoic rock with a high dip. The consulting geologists to the company made a special visit to Stutton on June 28th, 1895, and a thorough examination of all the core brought up was made on the spot. Professor Galloway, of the University College, Cardiff, visited Stutton and made an exhaustive examination, and acting on his advice the directors decided to suspend operations at Stutton and find a site for the next boring. Mr. W. Whitaker, F.R.S., and Mr. T. V. Holmes, F.G.S., were again approached and agreed that the next hole should be put down somewhere in the neighbourhood of Thorpe, Weeley, or Great Bentley, Essex, and the tender of Messrs. Vivians' Boring and Exploration Co., Limited, of Whitehaven, was again accepted. The landowners in the vicinity of the selected districts were approached with a view to the acquisition of a site for the boring, and eventually the Board succeeded in getting a specially favourable and convenient site on the estate of Mr. and Mrs. Weeley, at Weeley. An agreement was therefore entered into which gives the association rights over between 800 and 900 acres, and secures to the company one-third of the net profits arising from the working or sale of coal, for a period of 30 years, from the date of the agreement, namely, January 27th last. Work was commenced at Weeley on February 15th, and the total depth bored to June 27th was 622 feet, 426 feet of which was chalk and flints.—The Chairman, in moving the adoption of the report, said there was very little to be added. Describing the difficulties encountered at the Stutton boring Mr. Rapier said the directors persevered to a great depth, so that it would not be said they were in too great a hurry or that they lacked courage. Coal had been found in other districts below the same character of rocks as those pierced in the earlier stages of the boring, and they persevered to a depth at which the boring was very expensive per foot, and a general examination of the cores and all such facts as they were able to obtain from the boring made it conclusive that it would be wise to discontinue work at Stutton. For the second boring excellent terms were made with a family of the name of Weeley, at Weeley, Essex, and in a comparatively short time the work was commenced. For some time it went on very successfully, and by the latter part of June they had penetrated to a depth of 622 feet in something like 14 weeks. That was pretty good considering that for the most part chalk alternated with very troublesome flint stones. At 622 feet the contractors experienced very considerable difficulty through encountering a large flint, which was so obstinate that various means had to be taken to either break it up or pierce through it. This had occupied the last six or seven weeks, and the latest account was that they were very near succeeding. As regarded what they were to expect no one could possibly tell. They must patiently go on with the work as prudent men, as originally intended, and be guided by geological experts. It was hoped that after the high dip experienced at Stutton there was a fall at no great distance, and that there were material differences in the strata at Weeley as compared with Stutton. Whether it would be so no man could tell. The work had throughout been conducted with very fair economy, and the contractors had always treated them with every consideration, and for an undertaking of the kind the matter had gone on as well as could be expected. As to the financial question, a short time ago they had to make a further call upon the shareholders, which was well met, and for the present the association was in ample funds.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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Three months, 1s.; six months, 2s.; twelve months, 3s. 6d.; post free. All remittances to be made to STROWGER & SON, Wigan.

Editorial Notes.

SOUTH STAFFORDSHIRE MINES DRAINAGE.—On Wednesday, the 5th inst., a meeting of the South Staffordshire Mines Drainage Commissioners was held at the Drainage Offices, Dudley. It was resolved that a general drainage rate of 1d. upon every ton of slack, shale, limestone, ironstone, fireclay, coal and other minerals raised out of all mines within the drainage area be levied and assessed for the half-year ended June 30th last, and be payable on October 1st next.

BRITISH SOCIETY OF MINING STUDENTS.—The annual meeting of this society was held on Thursday, August 13th, at the Freemasons' Arms, Consett, co. Durham. Previous to the meeting a visit will be paid to the Consett Iron and Steel Works. After the delivery of a presidential address by Mr. W. H. Mungall, the election of officers and the transaction of other business, the members were conveyed to the Chopwell Colliery and the Garesfield Colliery. On Friday, August 14th, there was an excursion to Ashington, Woodhorn and Linton Collieries.

COLLIERY EXPLOSION IN SOUTH WALES.—On Tuesday, the 4th inst., an explosion occurred at one of the Main Colliery Company's pits, Bryncoch, near Neath, Glamorganshire. It is situated on the Duffryn estate, and the company have reached the 6 feet seam. Between 500 and 600 men are employed in the colliery, and on Tuesday morning about 360 went down the pit for the day shift. It is assumed that a fall had occurred, which interfered with the ventilation, and an accumulation of gas followed. The colliers detected the presence of gas, and most of them returned with all speed to the main opening and were drawn up. Scarcely had they gained the top when an explosion took place. Prompt measures were taken to clear the airway and restore ventilation, and the manager and under-manager, with a band of helpers, descended the workings in search of the men known to be left in the pit. The pit has hitherto been free from serious disaster, and the newest ventilating appliances have been in use. Five bodies have at present been recovered, and the death of one of the injured miners brings the total number of deaths to six. Mr. Cuthbertson opened the inquest at Neath Abbey on Wednesday. He expressed his deep sorrow at the occurrence of the previous day, and added words in high praise of the conduct of the officials of the colliery and the brave parties of rescuers. The inquest was adjourned until the 13th inst., when it was stated that shot-firing took place in the colliery on the morning of the disaster, but it was not shown that the explosion was due to this. It has been suggested that the explosion was caused by the ignition of the gas through the gauze of a safety lamp, the owner of which would no doubt be running, to endeavour to reach the shaft or to warn his fellow-workmen.

MR. MYLES BROWN IN INDIA.—In the present issue will be found the first half of an article on "Coal Mining in India," by Mr. Myles Brown. Last year Mr. Brown was a frequent and valuable contributor to our journal, as most old readers will know, and was awarded a gold medal as heading the list of successful competitors in the competition questions. A short time ago we acquainted our readers with the fact that he had been appointed manager of a colliery in India and that he had promised to supply us with some notes on Indian coal-mining at the first opportunity, which promise he has now fulfilled. It is very evident from our reading of his article that he has wasted no time in investigating coal-mining matters in that country; and the equable manner in which he speaks of the difficulties which an enterprising manager has to contend with leads us to believe that he is the man in the right place and will ride above all obstacles.

UNITED STATES COAL STATISTICS, 1895.—The total product of bituminous coal in 1895 in the United States (including lignite, brown coal and scattered lots of anthracite) was 135,118,193 short tons, valued at 115,749,771 dols., compared with 118,820,405 short tons, valued at 107,653,501 dols., in 1894, indicating an increase in product of 16,297,788 short tons, or about 14 per cent., and in value of 8,096,270 dols., or 7·5 per cent. The total number of men employed in the bituminous coal mines in 1895 was 200,182, averaging 196 working days, against 244,603 persons for 171 days in 1894. The product of Pennsylvania anthracite in 1895 was 51,785,122 long tons, or 57,999,336 short tons, valued at 82,019,272 dols. This was the largest output ever obtained, being 5,426,978 long tons in excess of that of 1894, and 3,599,816 long tons more than in 1893, the year of largest previous production.

NATIONAL ASSOCIATION OF COLLIERY MANAGERS.—The annual excursion of the Midland branch of the National Association of Colliery Managers took place on the 27th ult., when about twenty-seven members visited the Glapwell and Bolsover collieries, in Derbyshire. At Glapwell the party inspected the belts, screening and banking arrangements, the large air-compressing plant, and the endless-rope haulage arrangements. They also inspected the winding and ventilating arrangements, and a number of the members descended the pit to see the system of loading both decks of the cages simultaneously at the pit bottom. The party then left for Bolsover, where they were received by Mr. J. G. Houfton, the manager, who conducted them over the works, inspecting the belts, screening and banking arrangements, Walker high-speed fan and engine, the mechanical stokers, the electric lighting plant and the electric haulage plant on the surface. At this colliery the daily output is now over 2,300 tons. There are seven boilers, fitted with Proctor's shovel stoker and bars. The following are particulars of a recent test made with these appliances at this colliery:—Duration of test, 5 hours; draught, 520 feet per min.; average steam pressure, 80 lbs.; grate area, 27 square feet; average temperature of feed water, 152 degrees; water evaporated, 6,270 gallons; water evaporated per hour, 1,254 gallons; coal consumed, 8,736 lbs.; coal consumed per hour, 1747 lbs.; water evaporated per pound of coal, 7·17 lbs.; pounds of coal per square foot of grate surface per hour, 64¾ lbs.; price of coal at pit head, 2s. per ton; cost per 1,000 gallons, 1s. 2¾d.

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The Federated Institution of Mining Engineers.

A MEETING of the student members of the above association was held on Wednesday, the 5th inst., at the Queen's Hotel, Leeds. Mr. T. H. Cockin, of the Tinsley Collieries was called to the chair.

The Applications of Electricity in Mining Operations.

Mr. Roslyn Holiday read a paper, in the course of which he said there were hardly any uses to which power was transmitted by hydraulic, pneumatic, or mechanical agency to which electricity could not also be applied; but the vital point to the colliery proprietor was whether electricity could be applied to the purposes to which it was suitable about a mine without endangering the lives of the men, yet so that at the end of the financial year a lower working cost might be shown than if other modes of power transmission had been used. Whether it was economical to use electricity for all purposes of lighting and power-producing depended largely on local circumstances. In the larger number of mines where electricity was used it was mainly for lighting, not many using it for power alone. For lighting purposes the engines had to be sufficient to produce the maximum of light needed, yet this maximum would only be required in the winter months for some four hours per day, and it was obvious therefore that if more work could be found for the engines during the remaining hours of the day, it could be done without increasing the running cost. Proceeding to show how electrical energy was most economically produced from a large central station, and how the power generated could be used for various purposes, and including the production of heat for welding purposes in the mine, for which it seemed to be eminently suitable, reference was made to plants designed and put down by the author at Ackton Hall Colliery and elsewhere. Dynamos producing from 200 volts to 500 volts were recommended for lighting and for power, various forms of continuous-current motors described, and the advantage of varying powers obtainable for alternating-current motors alluded to, with the remark that alternating machinery was more costly than continuous-current plant for the same power, and alternating motors had the disadvantage that most of them are not self-starting, and those that are will not start against a heavy load. For cutting and drilling at the coal face, an alternating motor of the polyphase type was the most suitable, said the writer, for though not as efficient as other forms, it had no slide contact, therefore no sparking, and was consequently safe. On the question of the cables, Mr. Holiday remarked that where the shaft was clear the cheapest method was to hang the cables from the top, unsupported anywhere else, the support being perfectly insulated. The author used a cast-iron oil insulator 6 inches long, carrying a bolt with an iron clamp at the end, to which the cable was clamped. When a cable was to be hung, the drum on which it was wound was placed in the cage free to revolve, the loose end was fixed in the clamp, the insulator hung on the iron bar—its permanent support—and the cage lowered steadily, the wire unreeling as it descended; so that a cable 1,200 feet long could be hung in twenty-five minutes, including the clamping, &c. Once fixed, these cables had not needed the least attention. In carrying cables along the roads, if the roof and sides were good they might be taken overhead; if bad it was best to bring them in wooden troughing. All motor circuits should have ammeters in the engine room, and in some cases at the motor also, and finally the author added that in good machines the combination of dynamo and motor should not involve a loss of more than ten to fifteen per cent. of the total power delivered to them, while there were many electrical installations of which the total efficiency was not 40 per cent., thus showing the scope there was for careful planning.

The Chairman agreed with the author as to the utility of electrical machinery for mines, but doubted its economy for use as a motive power on the surface. He pointed to the danger arising from sparking, and thought there might be a great future for electricity in connection with sinkings.

Mr. T. E. Parrington submitted that any current of over 300 volts was dangerous. Alternating motors had the disadvantage that they always "pulled up" when slightly overloaded.

Mr. W. B. Bell submitted that motors used in the returns for necessary ventilation would be as invitations to disaster.

Mr. Holiday repeated that by having one large centre for the production of power great economy was effected by the use of electricity for the purpose of transmission, and said collieries ought to get a better return from electricity than any other users of power, because they could use a day-load as well as a night-load. He thought in sinking the dropping of water would ruin the cables, and as to danger, said the lads at Ackton Hall took shocks from a 525-volt current and seemed to flourish upon them, though he admitted there were conditions in which a current of 250 volts might cause death.

Afterwards the Chairman presented seven volumes of books on electricity, mining, &c., to Mr. Holiday, as the prize awarded by the institution. In the evening the members dined together, and Thursday and Friday were devoted to excursions to Micklefield and Ackton Hall collieries, the Yorkshire College, the Central Electric Lighting Station of the Yorkshire House-to-House Electricity Company Limited, &c.

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Coal Mining in India.

By MYLES BROWN.

(Specially Contributed.)

AT the commencement of this paper it must be understood that it will in no way be an exhaustive paper on the subject. In fact it will be rather superficial, owing to being written prematurely, as the experience of the writer in India only covers a few months. The incentive for writing is to supply some little information to those who are, especially at present, eager for Indian mining news. To make the paper as instructive and interesting as possible, it will be requisite to dwell briefly upon the following points, viz.:—(1) Coal Statistics, (2) Geological Aspect, (3) Mine Working.

Coal Statistics.

The increasing importance of coal as an article of Indian produce is shown by the following statement of the total quantity and value of Indian coal exported to foreign countries in each official year from 1886-87 to 1890-91:—

Year.	Tons.	Value in Rupees.
1886-87	199	2,489
1887-88	315	3,265
1888-89	15,796	150,299
1889-90	39,972	389,056
1890-91	26,336	263,884

In the *Pioneer*, 27th Sept., 1890, the following notes appeared:—"Ten years ago the total output from the Indian mines was a little over a million tons, while we imported 684,000 tons. Last year the Indian production amounted to over two million tons, and the imports had fallen to 600,000 tons. Another ten years, and the probability is that the imports will have vanished altogether." Doubtless the output will gradually increase, as the facilities for coal-getting are improved. The output for the year 1895 was 2,820,000 tons, whilst in 1884 it was only 1,397,818 tons.

Geological Aspect.

This department is destined to supply sufficient scope for the display of any geological talent which the mine manager of India may possess. No one can long remain in India before they are impressed with the scope there is for the energetical researches of the geologist. The geological aspect of the earth is constantly being modified by various agents; and collectively these agents produce the two great effects of construction and destruction. In India the various denuding and transporting agents carry on their work respectively, and, although in degree these agents in some cases are more excessive than those of any place like England, there is not that powerful rending agent which is produced when the thermometer falls to zero or freezing point. There is, however, the effect of continual excessive heat for months and also the effect produced by heavy falls of rain which endure for a season. Any amateur geologist may note the effect of these agents upon the uncovered rocks of India.

Before leaving England for India the writer was informed that on reaching India he would find that coal mining was effected in the familiar region of the carboniferous formation. But geological opinion in India differs from this assertion. A quotation from "The Manual of the Geology of India," by Mr. V. Ball, will give ample proof of the opinion of a geologist regarding the coal-bearing strata of India. Mr. V. Ball asserts that "although it may not appear at first sight to be of great importance, from an economic point of view, whether coal, provided of course that it is itself good, belongs to the palaeozoic, mesozoic, or kainozoic periods, the actual mode of occurrence is a matter of great importance in the tracing out of coal seams, and this varies with the age of the measures. The practical miner who, coming to India, expects to find here the familiar strata of the true carboniferous measures is destined to be disappointed." In the "Guide to the Economic Mineral Products in the Indian Museum, Calcutta, 1883," by Mr. F. R. Mallet, is the following:—"The coal of India belongs to several distinct geological periods, which include Lower Tertiary, Cretaceous, Upper Gondwàna, and Lower Gondwàna. Neglecting the Upper Gondwàna coal, which is of little importance, the coal of Peninsular India, *i.e.*, India south of the Indo-Gangetic plain, is almost exclusively Lower Gondwàna, while the coal of Extra-Peninsular India is almost exclusively cretaceous and tertiary."

The seams of the cretaceous are most important, although there are also beds of coal in the tertiary formation which are of importance, especially in Upper Assam. There are immense beds of coal in the Upper Assam district, the coal being of a highly calorific efficiency, hence it is much used for steam purposes. The writer asked the opinion of the chief engineer belonging to the steamer "City of Bombay," and he was told that the Assam coal was preferable to all other Indian coals.

As yet the writer has not had sufficient opportunity for gathering information regarding the coal-bearing strata, but up to the present the little information acquired and the few types of fossils found bear out the statement that the coal-bearing strata belongs to the cretaceous formation. As opportunities present themselves, care shall be taken to make the best of them, and no doubt at some future time more will be said on this subject.

The strata passed through in sinking and other mining operations are similar in many respects to those passed through in the carboniferous formation,

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namely, shales, sandstones, etc. In the course of sinking at Shampore Colliery, when passing through shale, the writer procured some fossilized impressions of leaves, similar in every respect to those determined by geologists as belonging to cretaceous plants. Two examples are given in figs. 1 and 2, namely, quercus rinkiana and ficus atavina. Up to the present at this sinking only these impressions of leaves and stalk-like carbonised vegetable matter have been noticed, but no doubt when nearing coal other fossils will be found.

Fig. 1

Fig. 2

The strata is traversed with faults, dykes, and other interruptions, and there are also numerous signs of intrusions of lava. A rather singular occurrence may be noted in one of the large seams at Shampore. Many of the galleries pass through six inches to one foot of sandstone, and at each side of the sandstone the coal is literally burnt to a cinder. The sandstone is the same in structure as that found in a bed or layer of ordinary deposited sandstone. No doubt at first it appears rather conflicting to find the sandstone unaltered and yet the coal burnt. A clue which solves this problem is that the fissure which contains the sandstone must have been caused by one of the many volcanoes which have occurred in the vicinity. When a volcano occurs, it doubtless acts much like an explosive charge, which, when it explodes, does the greatest amount of work at the seat of the explosion, yet there is also work done or power expended in every direction, causing lines of breakages or minute fissures, which of course are in the direction of the lines of the least resistance. Doubtless there is a resemblance to this in a volcano, and when the volcano occurred it would probably produce many fissures, all radiating from one common centre, which would be the mouth of the volcano; and these fissures being away from the main body of the lava would be the outlet for heated gases and other heated matters which would be forced to the surface by the power of the volcano. This would cause the coal to be burnt, and subsequently, by the various geological agents, the sandstone would be deposited in the fissure. The subject of geology may be further considered in some future paper, but there is one notable fact that nature in India, by her fast running rivers and by the torrents caused by heavy rains, and also by other denuding agents, at every turn has unfolded to the geologist a beautiful and instructive object lesson.

Quality of Indian Coal.—Indian coal stands much below English or Welsh coal as regards the general quality. India appears to have quantity but not quality. Below is the analysis of samples taken from a seam varying in thickness from 24 to 32 feet. The samples were taken so as to represent the quality of 24 feet 6 inches of the seam; above this height there are a few feet of bad coal.

In a note prepared for the "Dictionary of the Economic Products of India," Dr. W. Saise, Manager of the East Indian Railway Collieries, wrote as follows:—"The quality of Indian coal varies much. Below is a table of ultimate analysis of specimens from Karharbàri and Ranigauj coal-fields with analysis of English and Welsh coals for comparison:—

Coalfield (India).	Carbon.	Hydrogen.	Oxygen & Nitrogen.	Sulphur.	Ash.
Karharbàri..	78·20	4·34	7·89	0·42	9·15
E. Ind. Rail.	70·93	4·10	12·49	0·52	11·96
Ranigauj ...	74·31	5·12	9·67	0·47	10·43
England.					
Newcastle...	82·83	5·32	7·13	1·17	3·55
S. Wales ...	88·47	4·59	3·02	1·25	3·09 "

The writer is of opinion that the Indian samples are from the best seams, as the majority of seams show in their analyses less carbon and more ash.

ANALYSIS OF 24 FEET 6 INCHES SEAM.

No. 1, Bottom Section of Seam. = 8 feet.	Per cent.	No. 2, Middle Section of Seam. = 8 feet.	Per cent.	No. 3, Top Section of Seam. = 8 feet 6 inches.	Per cent.
Carbon Fixed	49·13	Carbon Fixed	48·65	Carbon Fixed	50·80
Volatile Carbonaceous Matter	28·45	Volatile Carbonaceous Matter	28·65	Volatile Carbonaceous Matter	27·65
Ash	20·67	Ash	21·20	Ash	20·05
Water	1·75	Water	1·50	Water	1·50
	100·00		100·00		100·00
CAKING COAL.		CAKING COAL.		CAKING COAL.	
Soft Coke	69·80	Hard Coke.....	69·85	Hard Coke	70·85
Sulphur.....	·35	Sulphur	·74	Sulphur.....	·5
Colour of Ash—White		Colour of Ash—Slightly Red		Colour of Ash—Slightly Red	

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On considering the analyses of Indian coal a notable feature is the numerous variations of the analyses—the coal belonging to the same seam and within a short distance changes very much in quality and in its mode of occurrence. As an example, a seam in the Shampore district varies considerably in quality and structure. At one part of the royalty it is nodular or cuboidal in structure and of a good quality, at another point in the same royalty the seam is cleaty and the quality is rather poor. It is a marked feature of Indian coal that the nodular structure gives the best quality.

The coal put upon the market gives an average of 10 to 15 per cent. of ash. The coal from the Ranigauj coalfield gives an average proportion of fixed carbon equivalent to 55 per cent. Coal from Karharbàri gives an increased quantity of carbon; on an average this coal will give 65 per cent. fixed carbon. The moisture contained in Indian coal varies, as different coalfields give different percentages of moisture.

The quantity of sulphur and phosphorus varies for different seams; 31 Ranigauj coals gave an average of sulphur ·85 per cent., and phosphoric acid ·83 per cent. Whilst the average theoretical calorific power of English coal is approximately 8,500 heat units, that of 31 Ranigauj coals was only about 6,500. The Upper Assam coal has a much higher efficiency in calorific power,—an average of 10 different coals was found to give 7,400 calorific power as against 6,500 for the Ranigauj coal. One disadvantage possessed by the Assam coal is the large percentage of sulphur which it contains; the best coal contains about 1½ per cent. The specific gravity of Indian coal varies from 1·32 to 1·4.

Consumption of Coal.—The following is culled from the report of the British India Steam Co., Limited, Calcutta, on Indian coal for sea-going steamers:—"Our tonnage of steamers in Indian waters has risen from 22,426 tons in 1868 to 251,319 tons in 1892, and, except for the vessels running from Bombay, where English coal can be laid down almost as cheaply as Indian, we practically burn little else than Indian coal, chiefly drawn from the districts round about Assensole, Sitarampore, and Burrakur. Indian coal has completely driven out English coal in Calcutta, both for sea-going steamers and for works ashore. Burmah is now almost exclusively supplied from Bengal. Ceylon takes a considerable quantity. The Coromandel Coast, as far round as Tutecorin, also draws its supplies mainly from Calcutta, and Indian coal has penetrated as far as the Straits Settlements, Java, Mauritus, and Aden. We have very little doubt that the consumption of Indian coal will continue to increase by leaps and bounds if it can only get cheap conveyance to the sea board. Some of the descriptions raised in the Ranigauj and Burrakur districts are of a poor quality, but others are exceptionally good. Roughly speaking, 125 tons of good Bengal coal are equal to 100 tons of Cardiff."

(*To be continued.*)

Competition Questions.

An award of 2s. 6d. will be made to the sender of the best answer to each of the questions given below. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered. Envelopes to be marked "Competition," and to reach us before September 4th, 1896.

We invite readers to forward questions for this competition.

(1) Describe a ventilating appliance to ventilate a pit (non-fiery) with 500 men and 30 horses; show by figures how you arrive at the result?

(2) How would you measure the loss of ventilating pressure in turning a sharp corner, say 90°?

(3) A pit, 200 fathoms deep, passes 200,000 cubic feet of air per minute, what amount of moisture will this suck out of the workings of the mine, taking the average temperature and saturation of the air in this country?

Awards.

For Answers to Competition Questions.

(1) Thos. Graham, Carron Colliery, Shieldhill, Falkirk, N.B.
(2) J. G. Bell, Evenwood, Bishop Auckland.

Commended.—Geo. A. Hawes, 8, Pilgrim Street, Murton Colliery, Co. Durham; C. Gregory, Bransley Villas, Whitehaven, Cumberland; E. Whitlock, 131, Woodhouse Road, Attercliffe, Sheffield; R. W. Hall, 1, Railway Street, Murton Colliery, Sunderland; W. P. Laws, 11, South St., Murton Colliery, Sunderland; W. Stansfield, 8, Quality Terrace, Wardley Colliery, near Newcastle-on-Tyne; H. Perkin, 1, Spring Grove Terrace, Alexandra, R.C., Leeds; J. Crawford, Longhurst Colliery, Morpeth; W. Morton, Chapel Street, Leabrooks, near Alfreton, Derbyshire; J. Finch, Green Lane, Hindley Green, near Wigan.

Answers to Correspondents.

Constant Reader.—We have inserted for the "Competition" one of the questions you sent; the other we do not understand.

A Regular Reader.—It would be a pleasure to us if correspondents exercised a little more ingenuity in the choice *noms-de-plume*. We regret our space does not admit of our adopting your suggestion.

Anxious.—This correspondent asks for an answer to the following question:—"How do you arrive at the number of gallons in an egg-ended boiler, 27 feet by 6 feet, laid horizontally for every inch in depth?" We cannot say whether he requires 72 answers, *i.e.*, one for every inch of the 6 feet or not. Will any reader oblige.

Surveying Apprentice.—We know of no book on "Mine Surveying" yet published which is suitable for the beginner. We are, however, engaged on an elementary work in this subject, which we hope will fill the want. B. H. Brough's "Mine Surveying" is without doubt the best book.

Con Grazia.—1. Indexes may still be had for Vols. I., II. and III. of Mining. Post free, 2½d.; also cases for binding. 2. The other matter we will consider settled.

J. W. McKean and Others.—Arrangements have been made with a well-known writer for a series of articles on "Pumps and Pumping," which will shortly appear in our paper.

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Rapid Section-Work in Horizontal Rock.*

By Marius R. Campbell, U. S. Geological Survey, Washington, D. C.

EVERY mining engineer who has engaged in prospecting for coal in flat-lying rocks understands the importance of constructing geological sections across the territory which he has to prospect. If the area is small and the time and means at his command are unlimited, he can construct such sections with the transit and level; but if the area is great and the examination hurried, as it frequently is, he will doubtless be puzzled how to proceed.

The writer, having been instrumental in introducing, for the conduct of such work, a new system, which has met with general approval wherever it has been tried, deems it a fitting subject to present to the Institute.

The Problem.

Throughout the middle and southern portions of the Appalachian coal-field the strata are monotonous in character, consisting of shales, coals and sandstones, and of but little value for purposes of correlation or the determination of stratigraphic succession. Coals are, perhaps, the least reliable means of correlation. True, they have been generally relied upon; but the glaring errors which have been made in correlating seams is sufficient evidence that, taken alone, the coals are of doubtful and uncertain value in carrying correlations from point to point in one field, or from one field to another. Since no one stratum can be depended upon implicitly, our method of work must be such that each stratum can be traced wherever possible, and correlations can be made from the aggregate evidence of all the beds, whatever their character may be.

Solution of the Problem.

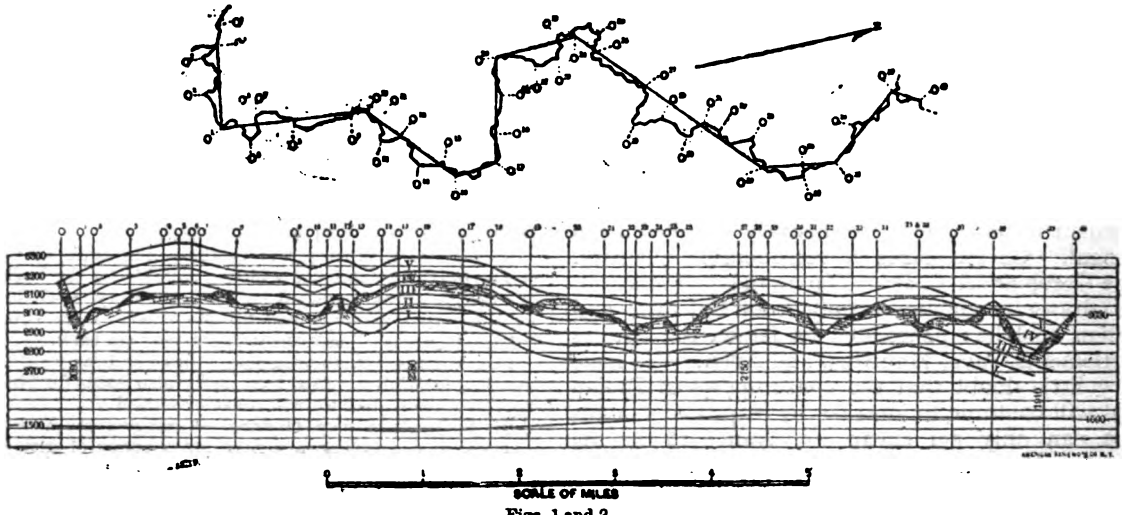
Since the rocks are necessary horizontal, the vertical element in the section is the most important. Time will not permit the use of the Y-level, consequently we are limited to the aneroid barometer and hand-level. The aneroid barometer is generally regarded as unsatisfactory; but in order to do rapid work the use of this instrument is a necessity. The hand-level should be used to supplement the aneroid on steep slopes and where horizons are well marked.

The note-book should be as large as the geologist can conveniently carry. The book in use in the United States Geological Survey is 7½ by 10 inches in size, and made of cross-section paper.

The method here presented presupposes a good base-map of the region to be studied, upon which are represented all of the roads and, if in an uninhabited, or but thinly settled, region, all of the more important bridle-paths. If such a map cannot be obtained, the geologist will perforce prepare his own map at the same time that he constructs his section. Through long experience, the geologists of the United States Geological Survey are able with a hand-compass and a protractor to make foot-meanders with considerable accuracy and great rapidity.

In order to render the explanation of the method of making rapid sections more intelligible, we will consider a concrete case taken from my own note-book and representing a section made in this manner in McDowell county, West Virginia. fig. 1 shows a plat of the road over which the section was made. This road follows a high ridge on the western side of Dry fork of Tug river, and is the principal line of communication between Bradshaw and Iaeger. For this kind of work, ridge-roads generally give better results than those following streams, since on the summits of the

* Abbreviated from the Transactions of the American Institute of Mining Engineers.



Figs. 1 and 2.

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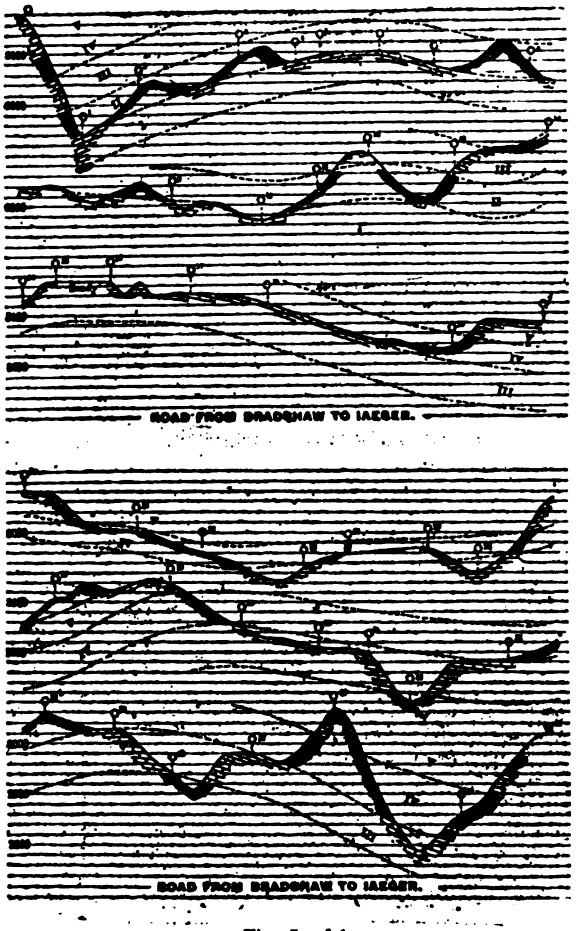
ridges sandstones and shales are almost always distinguishable. The section herewith presented was made during one trip over this road, and consumed less than half of a day for its completion. The only instrument used was an aneroid barometer, the readings of which were afterwards checked by known elevations along the line of the section.

Since the method is almost entirely graphic, it is well to adopt conventional symbols to represent the various kinds of rocks included in the section. Of course, all this is a matter of personal taste; but much time is saved by such symbols as are easily made and easily recognised afterwards. In the section illustrated I used a block-symbol for sandstones (varying the size of the pattern as the sandstone changed in the thickness of its bed), fine-line shading for shales and a heavy black line for coal-outcrops.

Figs. 3 and 4 are reproductions of the pages of my note-book upon which the original section was made. The note-book was carried open in my hands, and the barometer was held upon the open book, so that I could always read the elevation of any outcrop without the necessity of stopping the team for the purpose.



Figs. 3 and 4.

In constructing the section the horizontal element is almost ignored; but the vertical is made as nearly exact as possible under the circumstances. be large enough to show all the details of the section. A convenient vertical scale is adopted, which should The scale used in the example here given is 20 feet to a single space. In the original book this is about 100 feet = $\frac{5}{8}$ of an inch; but the scale may be varied to suit the work. Every observed outcrop is plotted in its correct relative position, as far as the vertical element is concerned; but the horizontal distances are merely estimated—the hills and valleys being sketched as the section is made up, without any particular effort to have them correct, except in elevation. At the starting-point, which was marked O on both map and section, the barometer read 3180 feet, which was assumed to be the elevation without any regard to the absolute elevation. In passing down the road the shale which caps the hill at the starting point was found to rest upon a bed of sandstone at 3170. This sandstone is coarse and heavy-bedded, and reaches to 3100. The contact between the shales and sandstone was seen at this point, as was also the contact between the shales and a lower sandstone at 3060. This is also a coarse sandstone and extends to 2990. Below that is sandy shale to the foot of the hill, where the intersection of two roads provides us with a tie-point, so our section is marked O^1, and the road-intersection on the map is also marked the same. This point is on the top of another bed of sandstone, which is well exposed on the road which descends from this point to Bradshaw. From this side-section we know that the sandstone is 65 feet thick; so it is plotted in on our section to assist in the correlation, if the road should cut this bed at any other point on the section. For convenience in describing the construction of the section, the various beds are numbered, beginning with the lowest sandstone shown in the section. Thus the sandstone beds are called Nos. I., III. and V., and the shale-beds Nos. II. and IV.

Many written descriptions of the kinds of shale and sandstone were originally made on this section; but it was impossible to reproduce all, so they have been generally omitted.

In passing eastward from the point O,[1] the road ascends on the shale for a vertical distance of 90 feet to a sharp bend in the road, which is used as another tie-point and marked on the plot and section O^2. The attitude of sandstone No. I. below the road is unknown, until the road passes over a low hill and descends into a shallow saddle, where the sandstone is seen immediately underlying the road. Since shale bed No. II. is exposed continuously from O^1 there can be no doubt about the identification of the sandstone stratum.

Throughout the entire section tie-points were established at frequent intervals or wherever a point in the road could be identified.

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The road continues in shale bed No. II past O^5, and at O^4 cuts through the bed of shale and reaches the sandstone below. The road follows near the top of this bed through O^5, O^6 and O^7; but at the last point again rises over a hill composed of shale bed No. II. There is an apparent arch in the sandstone (No. 1) between O^1 and O^7; but upon consulting the map it is found that the axis of this supposed arch is located at the angle in the road which unites the east and west with the north and south courses. There is a descent in each direction from this angle; consequently we conclude that there is a strong northwesterly dip in this region, instead of an anticlinal fold.

The hill between O^7 and O^8 affords a minimum measure of shale No. II; but since no sandstone was noted upon its summit, the exact upper limit is in some doubt. Beyond O^{10} the road ascends a hill 130 feet in height. Leaving sandstone No. I. at its base, it passes through about 70 feet of shale, and reaches the basal portion of an upper sandstone (No. III.).

This portion of the section illustrates well the trouble frequently encountered in constructing sections in Coal-Measure rocks. In ascending the hill from O^{10} the road rises distinctly above the sandstone (No. 1) and enters the shales above. These shales show in outcrop through a vertical interval of 70 feet, above which no rocks are visible. The soil is the only means of determining the character of the rocks; but the soil is sandy, and it is impossible to say whether it is derived from the sandstone which caps the hill or is the result of the disintegration of sandy shale or sandstone in the place where the soil occurs. Generally a single exposure will not suffice to settle the point, and the geologist must seek for further exposures of this interval in order to become better acquainted with the character of its rocks. In the section under consideration, this interval was afterward seen in a number of places, and the shale bed (No. II.) was found to be very constant and about 70 feet in thickness. Therefore, it seems probable that the blank space in the section below O^{12} is really sandstone belonging to No. III.

Sandstone No. I. passes below the road at O^{10} and was not seen again in the section.

The various beds were followed without any great difficulty to O^{27}, at which point the road passes upward through the sandstone No. III. and a greater thickness of the shales of No. IV. than had previously been found. The sandstone (No. V.) above these shales seems abnormally thin in this hill, but on the opposite side of the ravine, near the end of the section, it is nearer its normal thickness and is accompanied by a band of thin, flaggy sandstones above the heavy portion. This upper portion may be present on the hill at O^{28}, but it was not noticed.

This practically completes the field work on this section. Since the horizontal element of the section is merely estimated, it is not to be supposed that the section as constructed in the field will show correct geologic structure, but it does show the correlation of the beds as well as though the section was correct in both its horizontal and vertical elements. The identification of the beds is all that is essential in the field; the structure can be determined later, when the geologist has more leisure and better facilities for the work. True, the section here given is an exceptional one.

Office-Work.

The rough sketch of the field-section need not be gone over at once. It can be done to the best advantage in the office. When the geologist returns from his field-work, he reconstructs from his sketches accurate sections, with horizontal measurements corrected and barometric readings adjusted.

The sketch-section illustrated by figs. 3 and 4 is reconstructed in the following manner: A section-line is drawn on the map (fig. 1) along the general course of the road. Thus the first portion of this line connects O and O^4, the second O^4 and O^{10}, and in a similar manner for the rest of the section. On a very crooked road, like the one shown, some of the points, such as O^{24}, are a long distance from the line of the section; and if the dips are strong, allowance will need to be made for this fact in reconstructing the section. As a general rule, the dips are so light that a slight discordance between the road and the section-line will not affect the result; nevertheless, this point should be carefully watched and correction should be made whenever necessary.

The section is re-drawn on cross-section paper to any convenient scale, except that it is not practicable to construct it on a natural scale. Some vertical exaggeration is necessary in order to show details of stratification. The section is re-drawn on the adopted scale with reference point, O, O^1, O^2, etc., at their proper intervals, measured on the straightened line of the section. The finished section is shown by fig. 2.

By comparison with the note-book (figs. 3 & 4) it will be seen that the changes in structure are very slight, since with a large amount of practice the sketching can be done with considerable accuracy. The section as now constructed is still at an assumed elevation of from 2800 to 3000 feet. If the absolute elevation of any point on the section is known, the section can be corrected for sea-level; or if the elevations of several points are known, lines can be drawn on the section which will correct to a great extent the fluctuations of the barometer. Suppose the points O^1, O^{16}, O^{28} and O^{29}, are respectively 2030, 2280, 2150 and 1910 feet above sea-level; then we will measure down from them to

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some convenient datum-line, and use that instead of the assumed elevation as our standard for the section. In this case we will assume that the 1500-foot line is our datum. The elevation of the point, O^1, is 2030 feet above tide; hence it is 530 feet above the datum-line. Measure down 530 feet from O^1 and that will give a point on our standard-line. Doing the same for O^{16}, O^{28} and O^{39}, we shall have four points through which the line must pass. If the barometric readings on these points agree with the correct readings, our datum-line will be straight, but if the barometer fluctuated, the readings will vary, and the line will be broken. In the section shown on fig. 2, the barometer fluctuated during the construction of the section, consequently there is considerable correction to be made between O^{16} and O^{28}.

When this is accomplished, the geological structure of any given area is best shown by drawing contour lines on the surface of some prominent and persistent stratum. In the section here shown, the upper surface of any of the three beds of sandstone affords a good surface upon which to draw contours. If it is desirable to draw 100-foot contours, a scale can be run along the section holding 1500 to the datum line, and wherever the even 100-foot divisions are crossed by the surface of the sandstone, there would be located a contour-line. By proceeding in this manner with all of the sections over a given area, a great many points will be obtained on the surface of the sandstone-bed, which, when connected by lines, will represent the attitude of the surface in question.

By means of such contours the geologic structure of these flat-lying rocks can be brought out more successfully than by any other means known to the writer.

A contoured map affords very reliable information as to the best location for mines and the direction in which the entries should be driven. If the interval between the contoured surface and any coal-seam is known, the position of the seam at any point can be easily calculated by adding this interval to the elevation of the contoured surface, when the coal-seam is above the standard bed; or by subtracting the interval when the coal lies below the datum-surface.

This method has been employed by me for two years in quite accurate mapping of the Coal-Measures in an area of over 3000 square miles in southern West Virginia, and by another party belonging to the same organisation in central West Virginia.

Wherever tried it has been adopted, and is apparently susceptible of application wherever the rocks are approximately horizontal. In inclined rocks, its limit of usefulness is soon reached. Where dips of 5° prevail, the horizontal element of the section becomes so important that the results are not always satisfactory; and when the dips reach 10°, the system is entirely inadequate.

Mining Institute of Scotland.

A MEETING of this Institute was held in the Christian Institute, Glasgow, on Wednesday evening, the 5th inst., Mr. J. S. DIXON in the chair. Mr. DUGALD BAIRD's paper on "Duty of Pumping Engines" was further discussed.

THE HEALTH CONDITIONS OF COAL-MINING.

The SECRETARY (Mr. James Barrowman, M.E.) read a paper on "The Health Conditions of Coal-Mining." He said there was a widespread belief which frequently found utterance at miners' meetings and in speeches delivered in the miners' interests that the coal-mining industry was particularly unhealthy. It could not be denied that coal-mining was a dangerous occupation. With, perhaps, the exception of the railway industry, it was more prolific in accidents, fatal and otherwise, than any other occupation in this country, although, comparing the Inspectors of Mines figures for 1855 with those for 1894, it appeared that while the number of fatal accidents had fluctuated little, maintaining an average rate over the past forty years of 1,061 per annum, the output and the number of persons employed had increased almost threefold. There was no doubt that the health conditions of coal-mining had also greatly improved within the same period; but, apart from this, they wanted to know if there were diseases peculiar to coal-mining which had the effect of shortening the life of the miner, or if those diseases, which were common to all, were aggravated by mining conditions to such an extent as to justify the statement that the coal-miner was a short-lived man. When they considered that about one-fifth of the whole male population of the United Kingdom, between the ages of 25 and 65, were miners, it would be recognised that the question was one of some consequence. It was matter for surprise that the subject had received little attention in this country. As regards Scotland, there were no statistics published from which a comparison could be made of the health of persons engaged in different occupations, and those for England and Wales were fifteen years old. He went on to show that with one or perhaps two exceptions there were no diseases peculiar to the miners' calling. These exceptions were an affection of the eyes, termed "nystagmus," and, in a lesser degree, that disease of the respiratory organs which usually goes by the name of "miners' asthma." In discussing the subject at considerable length, the speaker pointed out that the death-rate of coal-miners from alcoholism was particularly low, which went, he said, to show that the occasional drinking to excess indulged in by many of them was less deleterious in its effects than the more frequent tippling of men in other occupations. On the whole, he said, they had good grounds for regarding the occupa-

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tion of the coal-miner as one of the healthiest, as even after including deaths from accident, the mortality amongst coal-miners was less than that of most manual occupations. Amongst the contributing causes towards this result he instances (1) the underground temperature was equable, and, on the whole, not uncomfortably high; (2) the bulk of the coal-miners live in rural communities and have the benefit of fresh air; (3) the coal-miner's working-day is a comparatively short one, and he seldom worked every day in the week. The Scottish collier had always had a hankering after a weekly holiday. As far back as the year 1641 an Act of the Scottish Parliament was passed ordaining colliers and other colliery workmen to work all the six days of the week, the reasons given being that they had been in the habit of taking frequent holidays, which they spent in "drinking and debauchery to the great offence of God and prejudice of their masters." Good as things were, they hoped to see them better. They could not entirely do away with all the causes of death and disease, but strenuous efforts were being made to lessen their effects. The composition of the gases met with in mines and their effect on the human system were receiving most careful attention from Dr. Haldane, Dr. Clowes, and others. Ventilation had been brought to a high state of efficiency; the resources of science were being taxed to provide an explosive that can be used without the risk of igniting firedamp; and better dwellings and improved sanitary arrangements were now the rule. All these were tending towards the bettering of the health conditions of coal-mining.

An interesting discussion followed, in which Mr. Barrowman's views were generally approved.

THE CAUSES OF DEATH IN COLLIERY EXPLOSIONS.

Dr. JOHN HALDANE, Lecturer in Physiology, University of Oxford, read a paper on this subject, in which he emphasised the destructive effect of carbon monoxide in the afterdamp. The paper was illustrated with practical demonstrations, and in the discussion that followed several medical gentlemen and Mr. J. B. Atkinson, Inspector of Mines, took part.

The discussion was adjourned.

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The Advantages of Steel Girders for Supporting Mine Levels.

BY THOMAS GRAHAM.

IF we confine ourselves to the question of supporting levels, which are in all cases permanent passages, and will probably be in use while the mine is being worked, it is quite safe to say that either steel bars or arches or a combination of the two are to be preferred to timber. Timber requires replacing very frequently, as it soon decays and is useless, and under heavy pressures it soon breaks.

An experiment was made with two Norway props. The first was 16½ inches circumference and 6 feet long, which broke under a weight of 90·8 tons. The second prop measured 23 inches in circumference and 7 feet long, which broke under a weight of 50 tons. A steel girder was next tried, which measured 6 feet long by 5 inches by 4 inches and weighing 16⅔ lbs. per yard, which was noticed to bend at 81 tons and continued to do so at 140 tons.

In the following case oak bars were used, measuring 6½ inches quarter girth and costing 2·66 shillings, and were replaced by steel bars 7 feet long, having a section of 5 inches by 4 inches by ½ inch, weighing 66 lbs. per yard, and costing 9·28 shillings. The price of the steel was therefore 3·49 times that of wood.

As an experiment under the last case cited, a level was supported alternately with wood and steel bars (wood props being used), but before any definite results could be observed the mine fired and was dammed off and abandoned. After nine months the mine was reopened and it was found that the steel bars had scarcely suffered at all. Owing to the falling of the roof where timber was set, over £100 was spent in wages, which would have been unnecessary had steel bars been employed throughout.

On a main level, used as a haulage road, twelve steel girders having a section of 6 inches by 4½ inches by ½ inch, weighing 78 lbs. per yard, and costing 20·95 shillings each, were employed to replace timber bars 9 inches quarter girth, costing 9 shillings each. The first cost of the steel was 2·33 times that of wood. The date of fixing being noted, it was found that from three to four sets of wood were used before the steel bars required removal. At one part of the above road there was a junction, and it was noticed here that the steel bars stood for thirteen weeks, while the longest time an oak bar lasted was a fortnight. Then supposing steel bars worthless on removal, the actual cost in the above cases would be less than timber, but all that has to be done is to take them out and straighten them and then they are ready for use again, as they seldom break.

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With regard to the relative economy of steel and timber, Mr. Ellison states that the cost of maintaining a road 1,000 yards long and containing 1,000 sets of timber is £480 per annum, while the cost of keeping a similar road by means of steel supports is only £180. The following tabulated dimensions are often used for steel supports:—

Depth in inches.	Width of Flange in inches.	Thickness of Web in inches.	Weight per yd. in lbs.	Length of span in feet.
5	4	$\frac{5}{8}$	$16\frac{2}{3}$	6 to 8
5	4	$\frac{1}{2}$	22	8 to 10
6	$4\frac{1}{2}$	$\frac{1}{2}$	24	10 to 14

The above cost on an average £5 10s. 0d. per ton.

For all permanent passages masonry seems to be preferable. It is more expensive to put in, as it requires a greater excavation to obtain the same effective area and for the masonry itself. To be successfully employed it has to be built continuous all round the road. In many cases the expense would be reduced in arching by having side walls with girders laid across and turning small arches from girder to girder parallel with the road—this especially in a double road, as otherwise a useless excavation would be required on the top. These arches are put in in lengths, according to the nature of the ground; 6 to 9 feet with a bad roof and from 5 to 7 yards with a strong one.

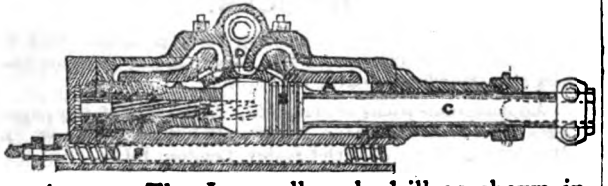
A first-class machine-pressed brick will withstand a pressure of 350 to 450 tons per square foot. Blocks of brickwork crush under less pressure than single bricks, and if set in cement not hard will crush under from 25 to 35 tons per square foot, but when set in Portland cement, nine months old, will withstand as much pressure as 400 tons per square foot. The usual cost of brick arching is 1s. 6d. per lineal yard for every foot the road is in diameter of 9-inch brickwork, and 6d. per yard is added for every $4\frac{1}{2}$ inches above 9-inch work.

Answers to Competition Questions.

GIVEN IN No. 17, VOL. IV.

THE INGERSOLL ROCK DRILL.

(1) Describe and illustrate the construction of the Ingersoll Rock Drill.



Answer.—The Ingersoll rock drill as shown in sketch is a direct-acting percussive class of drill, and consists of a cylinder, A, in which works the piston, B, connected to the piston-rod, C, which carries the drills. The piston has two fitting portions divided by a recessed or smaller portion, having gentle inclined plane at either end, and over this central portion is the valve D, in form a segment of a circle, the upper side of which is provided with recesses properly proportioned so as to admit the motive fluid. A rifled bar, E, and a ratchet-wheel having double pawls for rotating the drills, the mechanism being entirely enclosed. A screwed spindle, F, with a tappet keyed to the bottom with a sloping side, with a ratchet and pawl at the top end and a coiled spring in a box for automatically feeding the drills. This drill can make about 400 blows per minute, has either automatic or hand feed, and can be worked with steam or compressed air. It can also be used efficiently in any position, either vertically for drilling holes upwards or downwards, horizontally, or at any angle. When used for shaft sinking it may be carried on a tripod, and for tunnel work it can be mounted on a tunnel car, specially designed for the purpose. The Ingersoll rock drill is very simple, durable, and economical, combined with a good efficiency in operations. J. G. BELL.

SAFETY EXPLOSIVES.

(2) What are safety explosives, and what precautions are necessary to ensure their acting without flame?

Answer.—Safety explosives are explosives which have entered into their composition certain compounds which at the point of explosion evolve large volumes of gases which will not support any combustion, but *vice versa* will have a tendency to annul inflammable properties. The compounds are chiefly ammonium nitrate and dinitro benzol. The term "flameless," as sometimes applied to the above explosives, is innocuous, as experiments have shown. If only the high explosive be used, without any of the safety appliances to be used in conjunction with the explosive, the chief precautions are to comply with the C.M.R.A. and not stem with coaldust, and to have complete detonation. Manifold are the arrangements, however, which have been invented to reduce the risk of flame at the time of explosion to a minimum. Johnson's plug securely plugs the hole and prevents blown-out shots. Trench's compound is used for stemming, and has the property of annulling flame which may be evolved at the point of explosion. Perhaps the best and most reliable method, however, is that by Miles Settle, which is called the water-cartridge, and consists of a canvas bag filled with water and enclosing the explosive cartridge in a tin cylinder or stand. The stand is then inserted into the water-bag, and thus the explosive is completely surrounded by a zone of water. The most novel and up-to-date arrangement is that employed at the Sneyd Collieries, S. Wales. The explosive used is tonite, which is surrounded by a gelatinous cartridge, the contents of which are liquified by the heat evolved at the point of explosion destroying any flame or fumes that might arise. G. A. HAWES.

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MENSURATION.

(3) A pit is 16 feet in diameter and 200 yards deep. What is the weight of rock (shale and sandstone) excavated, and how much land will it cover when tipped as a square pyramid 32 feet high?

[For Answer see Correspondence, No. 18, Vol. IV.]

STEEL BARS AND ARCHES FOR USE IN LEVELS.

(4) Give some figures, with dimensions and weights, of steel bars and arches for use in levels in the place of timbers.

[For Answer see page 238.]

The Coal Trade & Foreign Competition.

In the course of his Presidential Address at the Annual Conference of the British Society of Mining Students, held on Thursday, the 13th inst., Mr. W. H. Mungall remarks that it would be conceded that our coal industry was an important one when it was remembered that about 700,000 persons, or nearly 2 per cent. of the whole population, were employed in and about the coal mines of Great Britain and Ireland. When they added those engaged in the disposal and transport of coal it became apparent that their industrial community dependent on the coal trade were by no means an insignificant proportion of their population. The coal trade of Great Britain might be said to date from the beginning of the 13th century, although coal had been worked in the 9th century. In 1855, the total output of British collieries was estimated at 64,453,000 tons, and in 1875 the output had increased to 133,306,485 tons. This gradual increase went on steadily with but little fluctuation till the maximum annual production of 185,479,126 tons was reached in 1891. During the succeeding two years the output decreased by over 20 million tons, but again in 1894 another high-water mark was reached, and the output was 188,277,525 tons, and in 1895 it still further advanced to 189,661,362 tons. According to official statistics the coal production of Great Britain exceeded that of any other country in the world, and was in fact in excess of the combined outputs of all the other countries of Europe. America came next, with an annual production of about 150,000,000 tons. Of European countries with which we came more immediately in competitive contact, Germany took the lead with a yearly production of over 90,000,000 tons, the output having increased from 81,960,000 tons in 1889 to 98,876,105 tons in 1894, or about 20·64 per cent. The increase was not confined to one or two countries, but was general, Austria-Hungary, Belgium, France, and Russia being notable examples. Canada, Australia, India, Japan, Cape Colony, and Natal were all producing largely increasing quantities. From this summary they would observe, he said, that the world's production of coal had increased by 83,773,310 tons. True, the output of Britain exceeded that of any other country, and she must thus be accorded the premier position in the world's coal yield, but they were forced to the conclusion that in supplying the increased demand for fuel Britain did not occupy that position which they boastfully accorded her. Why was this? Let them look at what other nations were doing, and they were brought to the subject of foreign competition. Germany was our most formidable competitor, her coalpits, ironworks, and engineering works being all in direct competition with our own. While England still sent a large quantity of coal to Germany, they had seen with what gigantic paces the latter country was endeavouring to supply her own demands. They were assured that German coalmasters were paying considerable attention to the question of British competition in Holland, which was Germany's best customer for fuel. In 1895 about one-third of the total quantity of coal exported from Germany was sent to Holland, the actual figures being 3,457,400 tons. Nor was France behind in this great struggle for existence. Russia, which they were apt to look upon as almost insignificant as a coal-producing country, was nevertheless worthy of receiving attention. During the last ten years the output had doubled, and the exports had increased four-fold. Since 1889, the production had increased by some 1,376,400 tons. Taking the same period they had been considering throughout they found that while the import of British coal into Belguim had increased by 20,000 tons, the import of coal from other countries had increased by 648,000 tons. In Russia the import of British coal had decreased by 145,000 tons, and that of coal from other countries had increased by 70,000. In Germany, France, Sweden, Italy, and Spain, Britain had had the greatest share of their increased import trade. But from some of our colonies, and from other countries, Britain was being gradually, but surely expelled. For example, of the 112,960 tons of coal imported by New Zealand in 1894, 2,079 tons were supplied by Britain, while New South Wales supplied 110,180 tons. In South Africa, too, we had signs of our coming exclusion from their coal markets. About a year ago the Governments of Cape Colony and the Orange Free State made considerable reductions on the railway rates on colonial coal, "with a view of enabling colliery owners in the colony to compete with European coal, not at the coaling stations only, but at the engineering works and the foundries adjacent to the ports." While the South African coal was not equal to that imported from Britain, France, or Belgium, it was reported to be well adapted for steam and engineering purposes, and with the revised freightage rates could be sold at a much lower price than European coal, and thus must stimulate the development of South African coal resources to the partial or entire exclusion of British coal. Last year (1895) 198,683 tons of African coal were purchased for the railways of Cape Colony and Natal, and for the current year it was anticipated that South African coal would be used almost exclusively. Of the African coal used in 1895, 160,988 tons were purchased at the price of 10s. per ton, and 23,837 tons at 15s. a ton. Of the imported coal, 5,560 tons were purchased at Cape Town at 27s. 6d. per ton, and 5,483 tons at Port Elizabeth for 38s. 11d. per ton. In France and in Turkey they found and agitation on behalf of the native coal owners for a reduction of customs duty and railway rates to enable them the better to compete with imported coal. In fact, on all sides they found that the struggle for the "survival of the fittest" was becoming more intense, and that if they were to maintain their position in the world's coal industry they must be "up and doing," and show some of that perseverance that was becoming characteristic of other nations.

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A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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Editorial Notes.

SIX HUNDRED MINERS TWENTY YEARS IN ONE EMPLOY.—It is 25 years since Mr. J. Jenkins, J.P., the manager of the Ocean Collieries, South Wales, was appointed. At that time the number of miners employed was probably 1400 or 1500. Mr. Jenkins has just celebrated his semi-jubilee by entertaining no less than six hundred veterans who have worked continuously for more than 20 years under his management.

THE COAL TRADE OF LUBECK.—According to a report from Lubeck, the imports of English and Scotch coal somewhat exceeded those of last year, the prices being much the same as usual. After the cessation of the shipbuilders' strike, on the Clyde, a rise in the quotations of English and Scotch coal was anticipated. The imports amounted to about 70,000 tons. Of coke, as of late years, imports were but small, viz., 156 tons as additional cargo with coal. The prices paid were, for English coal, from 13/3 to 13/6 per ton, c.i.i.f., Scotch coal, 12/3 to 12/6 per ton, c.i.f., English coke, 19/- to 19/6 per ton, i.c.i. Freights from England and Scotland were 4/4 to 5/- per ton.

ENGLISH AND GERMAN COAL.—A German correspondent of the *Times* states the Coal Producers' Association of Upper Silesia has petitioned the Minister of Public Works to reduce the railway rates for the transportation of coal from the Upper Silesian mines. The petition gives evidence to show that during the first five months of the current year the amount of English coal imported into Germany has been increased by 119 per cent. as compared with the same period of last year. The reduction of the railway tariff between the Westphalian coalfields and Hamburg, it is urged, has effectually checked the increase of the English coal trade at that port. A similar result might be expected in the case of Berlin were the rates between Upper Silesia and the capital to be reduced. Nothing has as yet been decided with regard to the petition, but there is no reason to suppose it will be rejected

THE NEATH COLLIERY EXPLOSION.—On the resumed inquest on the victims of the Neath colliery explosion, the jury found that two of the men died from suffocation and five from injuries; that the explosion was caused by an extraordinary outburst of gas consequent on a fall, and that the fireman in endeavouring to warn the workmen accidentally caused the gas to ignite by going through a working with a partly protected Davy lamp, the use of which they condemned.

COAL CRISIS IN BELGIUM.—Owing to increased competition the pits of Medide Mons, Paturage, and Wasmes are closed and more than 1000 men are out of employment.

THE GREAT COAL SCHEME.—It is stated that a syndicate is being formed in London with a capital of two millions sterling for the purpose of shipping English coal to the Continent *via* Antwerp or mayhap Amsterdam.

THE COAL & COKE TRADE OF FRANKFORT.—Consul-General Sir Charles Oppenheimer, of Frankfort-on-Main, in a report to the Foreign Office on the coal and coke trade of that place, says:—"The influence of the syndicate regulating the output of coal and coke is felt everywhere in the coal market. Consumers complain in many instances of its arbitrary and capricious actions in keeping prices high at home, and on the other hand trying to compete in the foreign markets with low tenders. The syndicate tries in the same way to obtain 'new' markets by underselling at home, while at the same time it raises the prices at such places where they possess absolute power. The dealers also complain of the curtailment of their freedom of action. The syndicate intends erecting branches in Hamburg—to counteract English coal—and at Mannheim, and also intends establishing storage yards on the Upper and Lower Rhine, taking more into its own hands the shipping of coal. The coal syndicate has been prolonged in 1895 for another 10 years, *i.e.*, to 1905. It saw itself forced to further reduce the outputs, indeed, by 15 per cent. for the summer months and by 10 per cent. for the winter. The business suffered in autumn through the unfavourable low state of water and the want of transport wagons on the State railways; in November, however, things improved. In general the old prices were maintained, but the prices for the 1896 contracts have been advanced. The competition of English and Scotch coal has been felt in Holland, and Belgian coal is making visible progress, the more so as it is produced under more favourable circumstances, especially by the using of much female labour and by the social burdens being smaller. The total participation, originally, when the syndicate was formed, was about 33,250,000 tons. It had already increased at the end of 1894 to 38,000,000 tons, and including the mines which of late have come into the ring, will probably have to be estimated now at not less than 41,000,000 tons, it will rise further, probably to 42,000,000 tons, if not 43,000,000 tons if the admission of mines which have applied for admission is sanctioned. The Westphalian Coal Syndicate comprised 7,617 coke furnaces at the close of 1895—a large number of furnaces, however, have since applied for admission. The output rose nearly to 5,000,000 tons. The export of foundry coke amounted for France to 971,785 tons, Belgium to 289,694 tons, Lorraine to 487,849 tons, Luxemberg 595,666 tons, Austria 117,402 tons. The export by sea amounted to 260,000 tons. Since the beginning of the syndicate—in 1891—the export has considerably increased. The transport of Westphalian coal and coke to Hamburg rose in 1895 by 105,000 tons, the import of English coal only by 23,000 tons. Various large consumers, such as gas companies, shipowners, and industrial establishments, have turned, though for only a part of their requirements, to Westphalian coal, whereas hitherto they had exclusively used English coal. The syndicate facilitated this transition by granting exceptional advantages. As is hereby seen, the exertions of the syndicate are directed to a great degree to removing the competition of English coal."

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Midland Counties Institution of Mining Engineers.

THE annual meeting of the Chesterfield and Midland Counties' Institution of Engineers was held in the Stephenson Memorial Hall at Chesterfield on Saturday last, Aug. 29th. Pending the election of a new president, Mr. E. Eastwood, J.P., presided. The following officers were elected for the ensuing year:—President, Mr. M. H. Mills; vice-presidents, Messrs. Binns, Coke, Southern, Bragge, Hewitt, and Thornwell; council, Messrs. Hepplewhite, Laverick, Morgan, Walters, Ashwin, Deacon, Fowler, Houghton, Hewitt, W. B. M. Jackson, G. A. Lewis, and J. B. Smith.

The SECRETARY announced the following new members:—Sydney T. Boan, Coalville, Leicester; Frederick Clench, mechanical engineer, Chesterfield; Captain Harold Dewhurst, owner of the Steatite Mines, Letterkenny, co. Donegal; Peter Sinclair Haggie, Gateshead-on-Tyne; Benjamin McLaren, Kirkby-in-Ashfield; and Wm. Maurice, Alfreton.

The representatives to the Federated Institute were re-elected as follows:—Messrs. Bainbridge, Binns, Coke, Deacon, Jackson, H. Lewis, Longden, Mills, Spencer, and the secretary as ex-officio.

It was recommended by the Council that Article 1, Section 6, of the rules, be altered as follows:—"There shall be three ordinary general meetings in each year, to be held in Chesterfield unless arranged for elsewhere by the Council, in April, August, and December, the meetings in April and December to be on the first Saturday in the month, at 2-30 p.m., and the date of the meeting in August, which shall be the annual general meeting, to be fixed by the Council. Anything in the rules affected by the foregoing intended alteration to be adjusted accordingly."—After some discussion the matter was referred back to the committee.

The annual report showed that 25 new members had been admitted during the year, as against 28 the previous year, the total membership on August 1st being 349. The income during the period from March 25th, 1895, to July 31st, 1896, came to £192 9s. 9d. in excess of the previous year, and was £145 19s. 5d. in excess of payments.—On the proposition of Mr. MILLS the report and balance sheet were adopted.

Mr. M. H. MILLS, the president-elect, then delivered his inaugural address. He began by referring to several matters of interest in connection with mining, and which he thought had not received the attention they merited from the members. He hoped during his tenure of office to see papers bearing upon these matters. All new undertakings in mining had at the present day to face heavy expenditure, in deep sinking and powerful machinery, with greater risks of the coal seams not containing the same thickness and quality throughout, as they were found more to the rise. It was therefore necessary for lessees to secure larger areas of coal and longer terms of lease than formerly was necessary; and owners of land under which coal lay, but whose area of itself was not sufficient to induce lessees to sink for one property alone, must join with neighbouring landowners in granting such leases as would enable the lessees to successfully compete with other collieries. He recommended the study of leases, and also said he would greatly like to see closer and wider attention paid to the question of sliding scales, which principle he should like to see applied to royalties—the royalty to rise and fall with the price of the coal in respect of which it is paid. In the case of large areas taken on long terms it appeared to him advisable to have a sliding scale on the thickness of the seam as well. Dealing with the matter of fixed rent for large areas and long terms, he found that the rule of thumb was gradually taking root for estimating the amount to be paid annually—a rule entirely devoid of reason. The intention was that the colliery should be vigorously worked, subject to the difficulties met with, and that alone must be their guide in deciding upon the amount to be paid as the fixed or certain or minimum rent, as he would call it. He urged upon the members great care in the arrangement of way-leaves, and in the consideration of means of transport, especially in like districts to that, where water carriage had been so long neglected. He thought surely it was possible to ship coal from Notts and Derbyshire at a much less cost than at present was done, and he hoped it would be the lot of a member to show how this could be accomplished. He regretted there was a strong feeling on the part of the men against machinery for "holing," and said the introduction of machinery in any case had been of advantage to the men—making theirs a labour more of mind than of muscle. The selected leaders of the men should not allow their political duties to throw the subject into the shade, but should take upon themselves all the duties pertaining to leaders of men, and boldly advise the wisest course.—A hearty vote of thanks was accorded the president for his address.

The following papers were read:—"The Causes of Death in Colliery Explosions," by Dr. J. Haldane; "The Gypsum Deposits of Nottinghamshire and Derbyshire," by A. T. Metcalfe; "Lifting a Vertical Rising Main by Expansion," by Wm. Howe; and "The Deposit at the Mill Close Lead Mine, Darley Dale, Matlock," by Cyril E. Parsons, F.G.S.

NORTH OF ENGLAND INSTITUTE OF MINING & MECHANICAL ENGINEERS.—At a general meeting held at Coolgardie, Western Australia, on July 13th last, it was unanimously resolved that a branch of the above institute be formed there, to be called the "Western Australian Branch." The chairman, secretary, treasurer, and committee were then appointed, and a committee-meeting is to be held at an early date to recommend candidates for election by the Institute.

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Coal Mines Regulation Act, 1896.

AN ACT TO AMEND THE COAL MINES REGULATION ACT, 1887. [14TH AUGUST, 1896.]

BE it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

1.—(1.) The power to propose, amend, and modify special rules for a mine under the Coal Mines Regulation Act, 1887 (in this Act referred to as the principal Act), shall include powers with respect to any of the following matters:—

(*a*) the nature and description of the lights or lamps to be used in the mine, and their custody and the mode of using and trimming them; and

(*b*) the description of explosives to be used in the mine, the mode of using and of storing such explosives, and of making and stemming holes, and the times at which and the manner in which shots are to be fired in the mine; and

(*c*) the number or class of persons, if any, to be permitted to remain in the mine or any part thereof whilst shots are being fired; and

(*d*) the watering or efficient damping of the mine or any ways or places therein; and

(*e*) generally the precautions to be adopted for the prevention of accidents from inflammable gas and coal dust.

(2.) While any special rules made under this section are in force in any mine, any general rule contained in section forty-nine of the principal Act, and any special rule established under the principal Act, shall, if and so far as it is inconsistent with any special rules made under this section, be suspended in relation to that mine.

2. Where any matter in difference is referred to arbitration under the principal Act, a majority of the workmen employed in the mine to which the arbitration relates may, on giving such security, if any, as may appear to the arbitrators or umpire sufficient to provide for the costs occasioned by such representation, appoint any person to represent the workmen, or any class of them on the arbitration, and any person so appointed shall be entitled to attend and take part in the proceedings of the arbitration to such extent and in such manner as the arbitrators or umpire may direct, and be subject to the same liability with respect to costs so occasioned as if he were a party to the arbitration.

3. The plan required to be kept in pursuance of section thirty-four of the principal Act shall show the position of the workings therein mentioned with regard to the surface, and the position, extension, and direction of every known fault or dislocation of the seam with its vertical throw.

4.—(1.) for sub-sections (1) and (2) of section thirty-eight of the principal Act shall be substituted the following sub-sections:—

"(1.) Where any mine or seam is abandoned, the person who is owner of the mine or seam at the time of its abandonment shall, within three months after the abandonment, send to a Secretary of State:

(i.) An accurate plan of the mine or seam, being either the original working plan or an accurate copy thereof made by a competent draftsman, and showing—

(*a*) the boundaries of the workings of the mine or seam, including not only the working faces but also all headings in advance thereof, up to the time of the abandonment;

(*b*) the pillars of coal or other mineral remaining unworked;

(*c*) the position, direction, and extent of every known fault or dislocation of the seam with its vertical throw;

(*d*) the position of the workings with regard to the surface boundary;

(*e*) the general direction and rate of dip of the strata; and

(*f*) a statement of the depth of the shaft from the surface to the seam abandoned; and

(ii.) A section of the strata sunk through, or, if that is not reasonably practicable, a statement of the depth of the shaft with a section of the seam.

"Every such plan must be on a scale of not less than that of the ordnance survey of twenty-five inches to the mile, or on the same scale as the plan used at the mine at the time of its abandonment, and its accuracy must be certified, so far as is reasonably practicable, by a surveyor or other person approved in that behalf by an inspector of mines.

"(2.) The plan and section shall be preserved under the care of the Secretary of State; but no person, except an inspector under this Act, shall be entitled without the consent of the owner of the mine or seam, or the licence of a Secretary of State, to see the plan when so sent until after the expiration of ten years from the time of the abandonment. Provided that such licence shall not be granted unless the Secretary of State is satisfied that the inspection of such plan is necessary in the interests of safety."

(2.) The High Court, or, in Scotland, the Court of Session, may, on application by or on behalf of the Secretary of State, make an order requiring any person who has, for the time being, the custody or possession of any plan or section of an abandoned mine or seam to produce it to the Secretary of State for the purpose of inspection or copying.

5.—(1.) The inspection before the commencement of work required by Rule 4 (i.) contained in section forty-nine of the principal Act, shall extend to all working places in which work is temporarily stopped within any ventilating district in which the men have to work.

(2.) A safety lamp shall not be used in any mine or part of a mine by any person employed therein unless it is provided by the owner of the mine, and no portion of any safety lamp shall be removed by any person from the mine while the lamp is in ordinary use.

(3.) In Rule 12 of the general rules contained in section forty-nine of the principal Act, for the words "nor shall coal or coal dust be used for tamping" shall be substituted the words "and only clay or other non-inflammable substances shall be used for stemming, and shall be provided by the owner of the mine."

6. A Secretary of State on being satisfied that any explosive is or is likely to become dangerous, may, by order, of which notice shall be given in such manner as he may direct, prohibit the use thereof in any mine, or in any class of mines, either absolutely or subject to conditions, and the provisions of the principal Act as to contraventions of general rules shall apply to contraventions of any such prohibitions.

7. This Act may be cited as the Coal Mines Regulation Act, 1896, and the principal Act and the Coal Mines (Check Weighers) Act, 1894, and this Act may be cited collectively as the Coal Mines Regulation Acts, 1887 to 1896.

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Coal Mining in India.

By MYLES BROWN.

(Specially Contributed.)

Continued from last issue.

Mine Working.

MINE WORKING in India is generally carried on under rather peculiar circumstances, and many are the methods or systems adopted for the getting of coal. The methods adopted are in some cases modern, but generally they are modified by the class of labourers engaged, who, in India especially, like to be considered, and although their ways and wishes are quite opposed to anything like good mining, they generally cling with tenacity to their antiquated and rude methods.

It is in this department that the mine-manager of India finds his difficulties, which are native to the country. It is necessary to exercise much patience, and whilst following his respective duties the old proverb, which states that "everything comes to him that waits," is often the only one which gives any solace to his disturbed mind. The native workers are as a rule very independent; they give no thought for the morrow—"sufficient for the day is the evil thereof." Should the chattel contain a day's rice they are happy.

The one disastrous fact regarding the vast majority of Indian natives is that they have no purpose in life. It may appear to the reader that this is going off the track a little, but when duly considered there is not anything which affects Indian mining so much as the existing state of the natives socially. It is impossible to dwell on this subject, but doubtless there is no country whose progress is so impeded by the ignorance and superstition of its natives as India. The natives' working time is very much limited, due to the superstitious celebrations which they adhere to—some with sincerity, and others not so faithful take the holiday for a spree.

It will perhaps be most interesting to give descriptions of various sections of work done in the getting of the coal, but again it must be understood that the view is only a limited one, due to the want of a more prolonged experience.

Sinking.—In the early days of Indian mining, and also at the present time, very many of the coal seams are opened out by driving in at the outcrops. It is unnecessary to dwell upon the impracticability of such a system. At present more shafts are being sunk to the dip of the seams so as to allow gravitation to aid instead of impeding the transportation of coal. The primitive native, and also others who are not natives to India, never considered that gravitation may act either as an incentive or as a hindrance to coal-getting, hence up to the present in many cases brute force s the chief agent applied.

Sinking is carried on by the use of both primitive and modern appliances. For instance, a sinking at Shampore was being sunk by the following methods: The pit was 13 feet in diameter, passing through shales and sandstones. The blasting was carried on with native powder (which is noted for its weakness), and the holes were all hand-drilled by the ordinary hand-drills. The kibble for lifting the debris consisted of a native basket; for lifting water a buffalo-skin bag, or four kerosene tins connected, were used. The raising of the sinking debris and water were effected by two hemp ropes passing over two small wheels, hung from a horizontal pole, which was supported by two vertical poles. At the outer or surface end of the ropes, and at certain distances apart, pieces of bamboo wood were inserted, so as to allow a row of women on each side of each rope. To each rope there were twelve women, in tandem fashion, and their arduous task was often brightened by them all joining in some of their native songs, which are often appreciated most by a European after they are finished, owing to feeling, as if released from some unpleasant strain on the mental organ. But this arrangement has now been superseded by the adoption of a small sinking engine, and dynamite will also be used instead of powder, which will be of great advantage as the strata passed through is very wet.

Methods of Working.—The most general adopted method is that of bord-and-pillar, or post-and-stall, although in some few places longwall and the Staffordshire method of working thick seams have been adopted. As an example of the nearest similarity to English mining it will be better to give an extract from a report on Indian mining prepared for the Dictionary of Economic Products:—"At Warova, Central Provinces, where 100,000 tons of coal per annum are wound by direct-acting engines out of two shafts 200 feet deep, the system nearly approaches the English. No women work underground, and work is constant from Monday morning to Saturday night. The work-time is divided into three shifts of eight hours each. The seams, which vary from 8 to 12 feet, are worked thus: Galleries or bords and headways are driven 12 feet wide, 6 feet in height, leaving the roof coal, and pillars 40 feet square. The coal is so hard that it has to be nicked and undercut and then blasted down. The pillars are worked by splitting each from one headway to another, and then taking the far end off in slices; the roof-coal comes with it."

To give a general idea the writer will describe the working carried on at present at one colliery, although it must not be understood that the systems at the described colliery are practised at every place. There is very much diversity in the methods adopted at the different collieries, for at some, the mines are being fitted up with the most improved modern appliances, and no doubt before long there will be a number of collieries in India with

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excellent facilities for coal-raising, that is regarding machinery; of course labour will still be a vexed question. The method of working the coal at the colliery under description is that of bord-and-pillar, or post-and-stall. At present two seams are in course of working; one seam varies from 24 feet to 32 feet in thickness, and the other is about 14 feet thick. The pillars are left 35 feet square, as the thickness of the superincumbent strata is very small. Practically no timber is used; the thickest seam has a coal roof, and the other is working under a band of shale, a few feet of coal being left above.

The structure of the coal differs at various points in the royalty. At some parts it is cuboidal, and at other parts it is very cleaty. The coal is of a hard nature, but up to the present no blasting has been done at the coal face.

The hewers use the "Universal" pick, and some of them adopt wedging—they undercut the coal and then wedge it down. The miners work in gangs, consisting of about 6 to 14 workers, and divide themselves for their respective work, as each gang cuts their own coal and transmits it to the surface. At this colliery, at which, when fully engaged, 300 to 400 miners work, there is not up to the present a single plate or tub in use; the whole of the coal transmission from the face to the surface is effected by the carriers with their baskets. The coal hewer commences his work about 9 or 10 o'clock a.m., and continues until 5 or 6 o'clock p.m. As a rule there are many rests and chats between home and the coal face. Sometimes after consultation amongst themselves, they deem it necessary to have an increase of wage, and should they not be successful in obtaining the increase they simply shoulder their picks and march off home. Sometimes, however, the native goes further than this stage, for he collects his household goods (which will all go under his or his wife's arms) and marches to a fresh field of labour. Many of them are continually on the move, and they appear to have no abiding place.

The following will represent the amount of work done by a gang of coal-getters:—A gang of 14 miners, working in a gallery having a face area of 64 square feet, cut and carried 400 cubic feet of coal, which is equal to about 9 tons. The distance carried over was equal to 200 feet, and the vertical height, which equals the rise from the gallery face to the surface where the coal was deposited, was equal to 33 feet. These miners are paid so much per 100 cubic feet cut and raised, and they deposit the coal in stacks one foot high at the surface. From here the coal is removed by coolies to the main coal stack, and they also receive so much per 100 cubic feet removed. The writer took some ordinary examples so as to represent to the reader an idea of the work done by these coolies, although at times their loads are more excessive than the examples given. In procuring the information the writer weighed by means of a true spring-balance both coolie and load, and it was rather an amusing affair weighing the coolies. The following are the examples taken:—

Description of Coolie.	Weight Carried (Coal & Basket).	Vertical Height Raised.	Distance Carried.
(1) GIRL. Weight = 48 lbs. Height = 4′ 1½″ Age = 10 yrs.	64 lbs.	16 ft.	330 ft.
(2) GIRL. Weight = 44½ lbs. Height = 3′ 10″ Age = 11 yrs.	59 lbs.	16 ft.	330 ft.
(3) GIRL. Weight = 44½ lbs. Height = 4′ 1″ Age = 9 yrs.	58½ lbs.	16 ft.	330 ft.
(4) WOMAN. Weight = 78 lbs. Height = 4′ 9″ Age = 18 yrs.	105 lbs.	16 ft.	330 ft.

No. 1 girl carried 62·5 cubic feet of coal, which is equal to about 1½ tons, working about 8 hours; the distance and vertical height were those given above. Six coolies, of No. 4 class, carried 600 cubic feet of coal, equal to 7½ tons, to the same height and distance. All the coolies carry their loads on their heads, with the exception of a few men, who shoulder their load. The women coolies did the given amount of work in about 8 hours.

Coal is picked or hand-screened into four kinds: steam coal larger than 2 inches cube, rubble larger than ¾ inch cube, smithy down to ¼ inch cube, and all coal smaller than that is called slack or dust.

Coal is transmitted from inclines to the depôt by bullock carts. Wagons are loaded by means of coolies and their baskets, the coolies receiving so much per wagon, and generally from four to six load one wagon. At times one coolie will travel a few yards and then walk up a plank so as to tip the basket of coal into the wagon, the vertical height being about 14 feet, and the total quantity thus lifted by one coolie in the filling of one wagon is equal to about 17 tons.

In connection with the respective departments of work there is no definite time fixed for the workers, which is, of course, due to the native prejudices—as a rule in all things he proves himself a very independent person.

There are both interesting and uninteresting sights to be seen in and about an Indian colliery. Sometimes a whole family work together, and those members of the family who are not able to toddle about are brought in small baskets, in which they pass away the time during their parents' working-hours. Sometimes a child of a few years is seen sitting amidst the coals, and on its lap is found a cloth containing a seed like food, from which it regales itself during its parents' absence.

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Doubtless it is only a question of time before a change is affected. Already at many places modern winding, hauling, and pumping engines have been erected, and at some places underground baskets have almost disappeared, being replaced by tubs. But improvements advance very slow, due to the ignorance of the natives, who adhere to the old rugged paths of antiquity rather than change to smoother paths which are presented by civilization.

As in the case of England, in many old mines are to be found the fragments of baskets, sledges, and other rude forms of primitive appliances, so no doubt in the future of India, appliances and materials which have, and even now fill the Indian colliery go-down or store-house will be only seen as relics in collections, representing antiquated Indian mining.

The foregoing paper only touches the different interesting points of Indian mining, which if they were taken separately would provide ample scope for many papers. (*Concluded.*)

Competition Questions.

An award of 2s. 6d. will be made to the sender of the best answer to each of the questions given below. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered. Envelopes to be marked "COMPETITION," and to reach us before September 18th, 1896.

We invite readers to forward questions for this competition.

(1) What horse-power would be required to haul 20 full tubs, each weighing 10¼ cwt., up an incline with a rise of 1 in 3½, at a speed of 200 yds. per min., the friction of the tubs being $\frac{1}{50}$ of the weight, and neglecting the weight and friction of the rope?

(2) A pair of winding engines have cylinders 30 inches diameter, and a stroke of 5 feet, and the steam pressure is 60 lbs. per square inch. What is the greatest diameter the drum can be made in order that the engines may be able to lift a load of 5 tons, allowing a margin of $\frac{1}{3}$ for overcoming friction?

(3) Describe how you would set about levelling a dook having a gradient of 1 in 2. Also show how you would level on a gradient of 1 in 25. State your reason for altering the mode of doing the work.

Examination Questions with Answers.

By JOSEPH CARTER, First-class Certificated Manager.

Questions given at the Examination for Certificates of Competency for the West Lancashire & N. Wales District, June, 1895, at Wigan.

FIRST-CLASS.

Principles of Mechanics & Machinery.

(CONTINUED FROM No. 19.)

QUES. 9.—Given a pair of hauling engines underground, worked by compressed air, 500 yards away; what difficulties may you expect, and how would you guard against them?

ANS.—The chief difficulties from the use of compressed air are as follows:—During the compression of air there is a generation of heat, such heat represents so much work lost, and owing to the temperature increasing the air expands, therefore we have a greater bulk of air for the work of compression than we have for the work to be obtained from it. The result of the above is that compressed air when expanding in the cylinder of the motor causes the temperature to fall to such an extent that the moisture in the air will freeze at the exhaust passages of the engine. To obviate these difficulties as much as possible the compression should be conducted in stages, such as by West's two-stage compressor, in which the air is first compressed in a low pressure cylinder, and then passed through an intermediate cooler to the high pressure cylinder for further compression. In order to diminish the loss from using air expansively without encountering the freezing difficulty, would be to have large air receivers near the compressors and underground near the engines. The main pipes should be of good dimensions, then the air would have time to deposit any moisture that was held in suspension in the air. In addition to the above the exhaust passages should be as large and straight as possible so as to have a good exit. When the moisture in the air has become deposited as above, we have then dry air for use in the motor, and no trouble from ice because of the absence of water.

QUES. 10.—What regulations would you enforce with regard to boilers and engines underground?

ANS.—In the first place I should appoint competent men to take charge of them. The boiler attendant I should hold responsible for the daily inspection of his boilers, and all their appliances such as safety valves, water-gauges, water valves, and feed water valves; these should constantly have his attention to see that they are in a good working condition and kept so. He must also see that a proper depth of water is kept in each boiler, and must not exceed the pressure stipulated. Each boiler to be thoroughly cleaned internally and inspected once each month. In addition, I would have each boiler thoroughly inspected every twelve months by an expert. Should the water in the boilers become dangerously low, the attendant must withdraw the fires (in accordance with special rule 106) and report the same to his superior officer and the engineman. Engines underground should also be inspected daily by the man in charge, and instructions given to keep the engine and engine-house clean and free from oily refuse, such as oily waste, &c., so as to prevent any fire likely to occur from any sparks or overheating of the working parts of the engine. In addition he must see that all the dangerous parts of the machinery are fenced off and kept so fenced, and should for any purpose of repairs the fence be pulled down, he must after such repairs are completed, put up (or cause to be put up) the fence as before without delay. Any defects he may find should be notified to his superior officers without delay. The daily examina-

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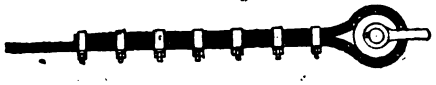
tion of both boiler attendant and engineman should be reported by them and signed in a book kept at the mine in accordance with the C.M.R.A.

QUES. 11.—State what requirements you would have made, and to what points you would specially direct your attention, if required to report on the efficiency or otherwise of the brake on a pair of 24-inch winding engines, winding coal from several depths in one shaft by means of two cages.

ANS.—In the first place the capabilities of a brake must (whether it be for a large or small engine) be such as to offer so great an amount of frictional resistance as to bring the engine with its full load when the steam is on to a stop in the course of a few seconds. If such is the case we may say the brake is an effective one, but in order to test it I should adopt the following experiments:—First of all I would examine the brake and all its connections to see if they were in thorough working order. I should then try with the full load in one cage and the empty cage as balance, at various points in the shaft to bring the cage to a stand, and hold it there by the application of the brake without the aid of steam. Also at the various points of loading in the shaft I should try if the brake would hold whilst loading at each of these places without putting steam against the engine. Then if I found that the brake would offer such an amount of frictional resistance as to hold the cage at any point in the shaft, and bring the cage to a stop without the aid of steam, then I should say it was effective and report accordingly.

QUES. 12.—Describe and sketch the best method of attaching the cage to a flat, round, and locked coil iron winding rope, the working load of which is 5 tons.

Fig. 1.



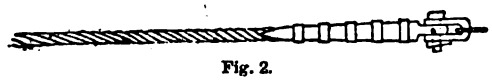


Fig. 2.

ANS.—In securing flat ropes to the suspension chains a good method is as follows:—The rope is bent back and secured by a series of clamps which will prevent it from slipping, and does not injure the rope as by the old method of rivetting. (See fig. 1) The method of capping round ropes, locked and otherwise, is to untwist the ends of the strand for a short distance, and the wires are bent back so as to make the end of the rope conical. A capel is now put on which is slightly conical, and this held on by rings or collars of iron which are put on hot and driven down tightly on the capel, and when these rings are cooled they grip so tightly as to prevent the rope from slipping.

(To be continued.)

Faulting & Accompanying Features Observed in Glacial Gravel & Sand in Southern Michigan.*

BY CARL HENRICH.

IN the winter of 1895-6, during the construction of the Jackson and Cincinnati railroad, running from Addison, Lenawee county, Mich., to Jackson, Mich., in a northerly direction, I had occasion to observe the following interesting geological features in a cut of this railroad made through a low ridge of gravel and sand.

The surface-deposits of this part of the county are, as is well known, of glacial origin. Gently rounded, long ridges of sand, gravel and clay intervene between the marshy bottoms and the lakes of the valleys. The nature of the deposits, varying from a sandy clay or clayey sand to fine and coarse gravel and pure siliceous sand on the one hand, and to a very tough, fine, uniform and often indurated clay on the other, as well as the irregular and sudden changes, sharply divided, between these materials composing the ridges, in the cuts made through them by the railroad, would admit of no doubt that this country owes its present surface-configuration primarily to the action of the last glacial period, which covered its surface with an immense ice-sheet. The well-known ice-markings on the huge granite, schist, greenstone and conglomerate boulders found everywhere imbedded and protruding from the surface, add their testimony to the other characteristics mentioned.

Most of the cuts made by the railway through the ridges showed in a marked degree the irregular arrangement and the sudden changes of and between the materials mentioned above.

One cut, however, known as Kelly's cut, or Kelly's gravel pit, about 4½ miles north of Addison, and about 1½ miles south of Kelly's Corners, exhibited an almost horizontal arrangement of layers of finer or coarser gravel, alternating with layers of fine, siliceous sand. This regular horizontal division or stratification of the materials would in itself have been remarkable, as it formed a notable exception to the irregular arrangement of the various materials composing the ridges, exhibited by the cuts of the railway farther south. But still more remarkable appeared a regular and well-defined system of fissures, which under angles of approximately 60° to 70° from the horizontal, and in two or three directions, traversed the horizontally stratified sand and gravel-layers, and everywhere faulted these layers. There are two well-defined systems of these parallel fault-planes, which intersect each other, probably under an angle of about 60° in the horizontal plane.

* Abbreviated from the Transactions of the American Institute of Mining Engineers.

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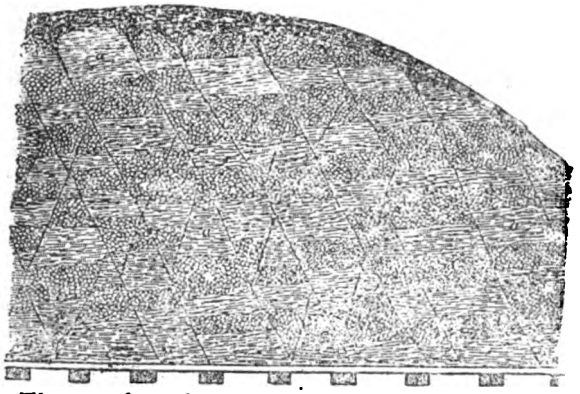
The alternating deposits of gravel and fine sand in horizontal layers bring out in a very marked manner the vertical throws caused by these faults. These parallel fault-planes are from 5 to 12 feet apart; and I was unable to find a single one which did not show a very marked throw, of certainly not less than 7 inches, of the gravel and sand-layers on either side.

Besides throwing and faulting the layers of sand and gravel, these systems of intersecting fissures were further characterised and brought out prominently by carrying, if not being actually filled with, nodules and ramifying tubules. Each of these contained a central cavity, around which a whitish powdery substance gradually but quickly passing into a reddish, ferruginous, cemented outer shell. The siliceous sand seemed to have been decomposed and powdered by the moisture or solution evidently circulating at times through the central cavity. The occurrence of these nodules and ramifying tubules recalled very vividly the characteristics and descriptions of the "*Loesskindchen*," and their disposition to form in apparent bedding-planes (in this case replaced by undoubted fault-planes).

The accompanying figure, from a sketch made by me in April, 1896, shows the appearance of the fault-systems on the east side of the cut.



The sand and gravel composing the ridge is overlaid by a sandy, clayey loam of reddish colour and variable thickness. It is on an average probably about 2 feet thick, but at the out-crops of the fault-fissures, and especially where the intersection of two fissures happens to come to or near the surface, the decomposition of the sand and gravel into loam reaches in places a depth or thickness of 4 and 5 feet, widening the fissures at their apexes.

The question naturally arises: What caused these extensive and well developed systems of fault-fissures in the loose material, not yet solidified or cemented into rock, and never overlain by any considerable thickness of other material from the time of its original deposition in the glacial epoch to the present day?

The explanation of the cause of these systems of fault-fissures, which occurred to me as the most plausible, is that the two masses of ice, or glaciers, which in converging directions scooped out the valleys of Silver Creek and of Goose Creek, exerted from both sides on the intervening ridge of sand and gravel a lateral pressure nearly horizontal. This pressure from both sides may have resulted in the development of these intersecting systems of parallel fault-fissures, their angle of intersection being approximately the same as the angle of intersection of the two glaciers exerting the pressure.

This occurrence illustrates, further, that the systems of fault-fissures which we find in stratified rocks may have been formed, and even the vein materials filling such fissures may have been deposited, before the materials forming these stratified rocks had been really solidified or cemented into rock, and before these rocks were overlaid by other rock-forming sediments. It suggests, also, a very natural explanation of a hitherto puzzling phenomenon, where a faulted stratified rock or series of such faulted strata of rocks are found between non-faulted masses or strata. Moreover, it would furnish a natural explanation of the occurrence in certain stratified rocks of veins or systems of veins and veinlets (often intersecting and called "stockwerks") which cut off sharply at the underlying or overlying rock-contacts, or at both. In fact, it occurred to me that this simple occurrence, accidentally observed, might be useful in explaning some hitherto puzzling problems in faulting and in ore deposits.

Cardiff Exhibition.*

By Sydney F. Walker.

THE exhibition itself is not as large as those that were held in London, Manchester, Glasgow, and Newcastle, but it is very complete, and the whole of the arrangements have been thoroughly well carried out.

There is a model coal mine, constructed as usual, of timbered roads surrounded by brattice cloth and boarding. The mine, of course, is more representative of a Welsh colliery than of any other district, but as far as my memory serves, it is more carefully carried out than the model coal mine which was shown at the Newcastle exhibition.

It is lighted by electric light, the current being obtained from the dynamos that are supplying the rest of the exhibition. On entering the mine, the visitor having paid his sixpence, is solemnly presented with a miner's lamp, for which however he has very little use; the few moderately dark places in the mine being devoted to lovers, who of course, are not always particular as to the amount of light present.

* From the Journal of the British Society of Mining Students.

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The usual electric engine plane signals are fixed to the props by the side of the travelling road, but hardly in the artistic fashion that one would have expected in an exhibition model coal mine. Telephones are also in evidence.

There is an electric haulage plant that is well worthy of careful examination. The electric motor drives a clutch bar by means of three hemp ropes. The drums are geared to the bar by helical wheels; and the drums are thrown in and out of gear, and reversed, by means of a novel form of clutch. The clutch consists of two powerful coiled springs surrounding the driving shafts. To bring them into action, the spring is wound up by the handle bar, and as it closes on the shaft it grips the latter, carrying it round with it. Handles are provided to apply the motive power to each clutch in either direction at will. The motor always turns in one direction, and is always running, or is intended to be, while the road is being worked, the stopping, starting, and reversing being performed by the brakes and the clutch gear. The system of haulage is main and tail.

There are two electric coal cutting machines, which are shown running, though of course, not cutting coal. The Goolden electric coal cutting machine is arranged parallel to the face of the coal. The long cutter bar, which is a cylindrical bar fitted with movable cutters, is turned first through an arc which brings it at right angles to the machine and in the position which it would have occupied if it had been pushed straight into the coal at right angles to the face, *i.e.*, starting from a position parallel to the face of the coal, the cutter bar, sweeping through its arc and driven by the electric motor, gradually cuts itself into a position at right angles to the face; the bar itself being then imbedded in the coal to the depth it is required to cut. Arrived in this position, the cutter bar is revolved and the machine as a whole is gradually pulled onward as the coal is cut.

The other electric coal cutter, the Jeffrey, is an importation from America. The cutter in this machine consists of a chain with movable cutters, working round the platform upon which the electric motor and other machinery stands. The whole platform, with that portion of the cutter chain which lies in front, is intended to be forced bodily into the coal until the required depth of cut is obtained, when the whole machine is withdrawn, moved on to a fresh place and re-started.

A small electric drilling machine is also shown and an electric pump will be fixed shortly.

The current for the whole of the power machines is supplied from a separate plant, forming a portion of one of the exhibits inside the exhibition.

There is a model, also in the mine, of the Victor hauling engine. The mine is ventilated by a small Waddell fan.

There is also a very well executed working model, on a very small case, of a gold mine in Colorado. Small model men are continually wielding small picks and shovels, loading into small trams, which are hoisted up a small shaft. The model is very well carried out, and the effect is considerably increased by the use of mirrors.

There is a small electric railway also in the grounds. A 6 H.P. gas engine works a 20 unit dynamo (20,000 Watts), furnishing 250 ampères at 80 volts. From the dynamo, the current, after passing through the switchboard, is taken to two copper conductors, placed between the track on the sleepers, and from these the motor takes its current. Three cars are run, each stated to be capable of carrying sixteen passengers. The leading car carries the motor, the others being what our American cousins call trailers. The motor is geared directly to the driving axles, through a pinion and bevelled wheel, the reduction being, so the attendant stated, 12 to 1. A peculiar feature about the arrangement is, that the motor stands upright in a place provided for it, between the two compartments of the car, in place of being carried under the car, as is usually done. For starting, the attendant told us 120 volts, 250 ampères were required, and from the appearance of his apparatus I am inclined to think he may have expended more energy than he supposed. For running the three cars fully loaded, once they are started, 80 volts, 25 ampères is stated to be sufficient. The track is circular and very small, but presents points of interest. The same firm also exhibit the scissors arc lamp, which is somewhat novel in its arrangements. There are 160 Brush arc lamps distributed over the grounds and the inside of the buildings, furnished with current from four Brush dynamos, each giving 2750 volts, and 10 ampères.

There are also three Mordey alternating current dynamos, all working at 2000 volts, two furnishing 17·5 ampères, and one 12·5 ampères. The field magnets are excited by two Brush Victoria continuous current machines, each furnishing 60 volts, 60 ampères. The alternators furnish current for 660 glow lamps of 16 C.P., distributed through the building; Mordey transformers being employed to reduce the pressure to 100 volts.

The arc lamps in the grounds are suspended from the same poles that carry the conductors. Those in front of the main building are suspended in the form of coronas from the tops of special iron poles, similar to those that were used in the Manchester exhibition. The arc lamps are of a new pattern made by the Brush Co., on the lines now so common with arc lamps of the Brochill Pell, in which a friction pulley and balance weight are employed, controlled by the current. The automatic pass-by, always a prominent and useful feature of the Brush arc lamp, is now placed in a separate case by itself, suspended above the case carrying the ordinary mechanism of the lamp.

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The dynamos are driven, the four Brush arc machines and one Mordey alternator, from a main shaft, which is driven by two pairs of compound engines, one pair of 250 I.H.P., vertical, one pair of 220 I.H.P., horizontal. The other two Mordey alternators are driven by two pairs of compound engines, each pair of 66 I.H.P. The driving shafts of the two pairs of engines are connected together by a friction clutch. The exciter dynamos are driven by small belts as usual.

Four Babcock and Wilcox water tube boilers, each of 200 I.H.P., are employed, the feed water passing through a feed water heater to the boilers. The main steam pipes are electrically welded. The usual switchboard is provided for throwing any dynamo on to any circuit at will. One pole of each the high tension circuits is connected to earth. The exciter dynamos provide current for the electric launches so-called.

The current for the electric hauling engine and the electric coal cutters is supplied by a dynamo inside the building, exhibited by Messrs. Easton, Anderson, & Goolden, and driven by one of their high speed engines. Current is also furnished by this dynamo for driving other exhibits, notably, the Niagara pulveriser, and a tool shaping apparatus. The Niagara pulveriser is a very interesting apparatus, the principal feature of interest being the method of selection employed for drawing the material that is sufficiently crushed out from its surroundings. This is accomplished by means of an indraught of air which sucks out all the dust below a certain specific gravity, the remainder falling back to be re-crushed. The crushing process is a modification of the now well-known rolling ball apparatus. A heavy sphere rolls round inside a cylinder, the cylinder being provided with projections which gradually allow the material to climb to the centre, where the indraught of air acts.

A good many large block samples of South Wales coal are exhibited by the various companies. The United National Company also exhibit a complete sample section of the seam, taken from the Abercarna pit, other collieries show samples of the strata, at different depths below the surface. There are exhibits of slate, pennant stone, and others; also of boring apparatus and the cores produced by them.

In the main body of the machinery section, are samples of fans, hydraulic tanks, compressed air and pumping engines, steam hauling engines, electric pumping plant, etc. There are also a number of very interesting models, many of them lent by the South Kensington authorities:—A model of the De Beers mine; a model of a gold and silver mine in Japan; a model of a mine in Saxony; a model of the winding gear at De Beers; a model of diamond working machinery. Several working models of coal tipping and other apparatus in connection with shipping coal and the protection of harbours.

H.M. Inspector's of Mines Report for India, 1894-5.

Mr. Grundy's report for the year ending June 30, 1895, has just been issued. The number of mines at work is 367, of which 174 are coal mines, 66 mica mines, 35 limestone mines, and 46 stone mines. Other substances are mined, including salt, fire-clay, plumbago, manganese, gold, ruby, sapphire, spinel, soapstone, fullers earth, and borax. The total number of persons reported to be employed during the year was 25,768, but returns were not received in every case. Of the number reported 5,919 males and 3,113 females were employed above ground, and 13,485 males and 3,251 females below ground. The total output of coal was 2,559,967 tons. In 1878 the total output was a little over one million tons, of which Bengal raised 956,000 tons. Of the total output of coal for 1894, the return for Bengal gives 1,770,888 tons, an increase for Bengal of 144,888 tons over the output of 1890.

The greatly increased production has not lowered the prices or flooded the market with coal; on the other hand, in 1894 and in the beginning of 1895, the ruling prices for coal of fair quality were good; as compared with working cost they might be described as high, and even poor coals could be sold at a fair price. It is stated to be not unusual to work out coal at an all-round cost of not more than 1—8 rupees a ton; that good coal has sold at the pit as high as 5—8 rupees a ton, and that a profit of 2 rupees a ton was not thought to be excessive.

With regard to the number of accidents that occurred during the year, thirty per cent. of all the deaths below ground were caused by falls, the number of deaths being 27; of these there were 5 females killed. The total deaths in shafts were eighteen or twenty-four per cent. of all deaths underground; of this number 4 were females. The total deaths by miscellaneous causes below ground was thirty or forty per cent. of the total below ground. Explosions of firedamp caused the deaths of 13 persons, and suffocation by gases 1 death. Five deaths were caused by explosives and 8 by trams and tubs. The total serious accidents other than deaths by miscellaneous causes below ground was 25. There were 10 deaths caused on the surface, or 11·76 per cent. of the total deaths; of these deaths, 3 were females. Half of the number of deaths caused on the surface were on railways and tramways belonging to mines.

In the report are descriptions of four of the principal collieries, particulars of which we will probably give in a subsequent issue.

When ordering goods or opening correspondence with an advertiser in the columns of this paper, please mention that you saw the advertisement in "Mining."

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Answers to Competition Questions.

GIVEN IN No. 18, VOL. IV.

PROPERTIES OF STEAM, GAS, AND COKING COALS.

(1) What properties are most valued in steam, gas, and coking coals respectively?

Answer.—STEAM COAL.—The most valued properties in this variety of coal may be enumerated as follows:—1st. That it should give off intense heat. 2nd. That it should give off little smoke. 3rd. That it should give off no flame. 4th. That it should have little or no sulphur in its composition. 5th. When burnt it should not cake together. A coal with the above qualities is *par excellence* for producing steam.

GAS COAL.—In this coal the following properties are mostly valued:—1st. It ought to contain a large amount of hydrogen. 2nd. It ought to be easily kindled. 3rd. It ought to burn freely and quickly.

COKING COAL.—The most valuable properties in this description of coal are:—1st. To have a good amount of carbon in it. 2nd. To have no sulphur. 3rd. To yield little or no ash when burnt. 4th. To contain a large amount of bitumen, for this is what binds or cakes the coal together on being burnt.

WM. P. LAWS.

LANCASHIRE SYSTEM OF WORKING INCLINED COAL SEAMS.

(2) Describe the Lancashire system of working steeply inclined coal seams.

Answer.—The method of working coal seams under the name of the Lancashire method, partakes in a measure a combination of longwall and pillar and stall systems. It is like longwall from the fact that the pillars are removed almost as soon as they are formed by means of wide lifts like a longwall face. It resembles pillar and stall, because the coal is split up into rectangular blocks. Two roads are driven from the shaft direct to the dip, and from these a pair of levels, 30 yards apart, are driven to the boundary of the district at intervals of 200 yards. When the boundary is reached two sets of levels are connected, and the block of solid coal thus found is split up into pillars by means of drivages at right angles to each other, as per sketch (fig. 1). As soon as a certain number of pillars have been formed, their extraction is commenced, the lifts being taken to the rise, and advanced step fashion, as shown by fig. 1, from 12 to 15 yards in width, and taken forward like a longwall face. A line of rails is carried up by the side of the solid coal, the roads being kept

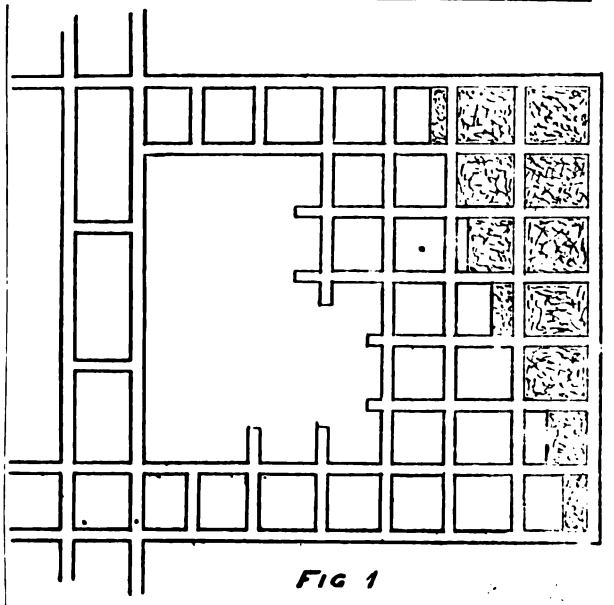

FIG 1

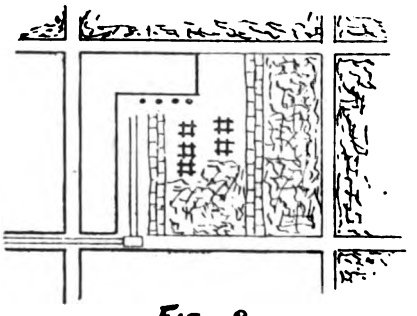

FIG 2

open by means of packs, as shown in fig. 2. The face is supported by two rows of chocks placed two yards apart, while a third row is being removed as the face advances, and the workmen keep themselves safe by means of props set near the coal face.

THOMAS GRAHAM.

EQUIVALENT ORIFICE.

(3) What is meant by *equivalent orifice*, and how is the term applied in discussing the efficiency of ventilating machines?

Answer.—The theory or practice of equivalent orifice was introduced by Mons. M. Murgue, a French expert, which has been accepted by the mining community, and although it does seem a queer phenomena that the resistance of a whole mine of considerable dimensions can be measured by an aperture fixed in a particular place, yet Mons. Murgue compares every mine to an orifice in a thin plate, which he calls equivalent orifice. The air in passing through a mine meets with a

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certain amount of resistance, and suppose that resistance was equal to a W.G. of 2·5 inches, then the equivalent orifice of that mine would be an aperture in a thin plate passing the same quantity of air and producing the same W. G., which represents the area of passage of all the air through the mine. The equivalent orifice depends on the laws relating to the flow of fluids, being chiefly affected by what is known as the *vine contracta*. The equivalent orifice is a means of enabling ventilating fans to be more fairly compared the one with the other, and throws some light on the vagaries of various fans; for example, when one fan produces 100,000 cubic feet per minute with 3 inches W. G., and another of the same dimensions running at the same speed, produces only 75,000 cubic per minute with 4 inches W.G., if we could understand that in the one case the equivalent orifice was 22 and the other 14, the contradictory condition of things would be made clear. It will not be out of place to state here that an error into which some mining students fall into is by confusing the area of equivalent orifice with the orifice of passage. The latter term is implied by the fact that a ventilator while exhausting the air from the mine, forms at the same time an obstacle to the passage of air, causing a suitable loss of duty. THOMAS GRAHAM.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

(1) Thos. Graham, Carron Colliery, Shieldhill, Falkirk, N.B.

(2) W. P. Laws, 11, South St., Murton Colliery, Sunderland.

Commended.—J. G. Bell, Evenwood, Bishop Auckland; T. Gillespie, 384, Main Street, Maryhill, Glasgow; J. H. Senior, 16, Thompson Street, Rawmarsh, Rotherham; S. Davies, Barrow Farm, Worsbro., near Barnsley; J. Finch, Green Lane, Hindley Green, near Wigan; W. Dickinson, North House, Nettlesworth Pit, Durham; G. A. Hawes, 8, Pilgrim St., Murton Colliery, Co. Durham.

Correspondence.

A CORRECTION.

Sir,—While looking through the Answers to Competition Questions in No. 5, Vol. IV., I notice what I think to be an error made by T. E. Aitchison. The error I refer to is in Question 1, and he goes on to find the pressure the W.G. should show in the shafts, which I understand to be correct. But in the airways he first divides the total quantity by 4, to find quantity passing in each. He again divides this by the area, 24 square feet, to get velocity, and so on. Thus he deals only with one of the airways, and then he works it out to 5·23 lbs. Now I think he should have multiplied this by 4 to give the pressure in the four airways, and then the answer would be 5·23 × 4 = 20·92 + ·07 downcast + ·06 upcast = 21·05 lbs. pressure $\frac{21{\cdot}05}{5{\cdot}2}$ = 4·048 inches W.G., this is what the W.G. should show. I should be pleased if T. E. Aitchison would explain it for me, as to whether he or I is correct. Hoping I am not criticising too much.

"FORGET-ME-NOT."

A CORRECTION AND A TESTIMONIAL.

Sir,—In your number for August 8th, page 225, there is a winding-engine question worked out by Mr. Joseph Carter. Is there not an error in adding ½ for friction (2963 lbs.) and then using the formula $3\sqrt{\frac{L}{P}}$ As I understand this very useful formula, which was explained in the January and February numbers of your paper, $3\sqrt{\frac{L}{P}}$ makes provision for the ½ for friction, and so the 2963 lbs. should not be added. Have found this formula, $d = 3\sqrt{\frac{L}{P}}$ most useful in winding calculations, and have brought it before the notice of my mining classes. Your excellent little paper is taken by nearly all my best pupils, and I always recommend it to my classes. L. W. T.

[The above is a portion of a letter from a Monmouthshire mining lecturer. He is correct as to the error, and we offer him our thanks for pointing it out. We hope his opinion of *Mining* is shared by all its readers, and would be obliged if other mining lecturers followed his example and recommend *Mining* to their classes.—ED.]

PLAN OF THE NORTHUMBERLAND AND DURHAM COALFIELD.

Sir,—I should be glad if any of your readers could tell me where I can get a plan of the Northumberland and Durham coalfield, showing all the principal faults and other particulars at a scale of about two or three inches to the mile. Hoping that some one will oblige. JAMES HARRIS.

UNSOLICITED TESTIMONIALS.

Sir . . . I have just obtained my 2nd-Class Under-Manager's certificate, and I may say that for good sound instruction and teaching in mining, your paper, *Mining*, is second to none in the market for price and quality. I have derived very great benefit from it, and I shall recommend it to all my friends. MATTHEW MOWYLEY.

Sir,—I hereby beg leave to state that I received 5/- award for successful answers in prize competition, and offer my thanks to you. It is a pleasant surprise to me, but I must say that I have received a great amount of assistance from the pages of your paper from its very commencement.

THOMAS GRAHAM.

STEAM PRODUCTION.

Sir,—I think the answers to the following questions will be of great service to many, *i.e.*, the method of calculating the following:—(1) What is the heating value of the fuel burnt? (2) What is the evaporative power of the boiler used, having a given heating and grate surface? (3) What is the value of the economiser or feed-water heater? (4) What is the rate of evaporation and combustion per square foot of heating and grate surface? ASPIRA.

[An award, *ad valorem*, will be made for answers to the above questions.—ED.]

Answer to Correspondent.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 22. Vol. IV. Sep. 19th, 1896.

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Editorial Notes.

Coal Production in South Africa.—The total output of coal from the collieries in the South African Republic in 1895 amounted to 1,152,206 tons, an increase of about 400,000 tons over 1894.

Coal Production in New South Wales.—The estimated outputs and values of coal from the southern mines during the year 1895 are as follows:—Austinmer, 16,842 tons, £5,894; Bulli, 5,000 tons, £1,500; Bulli (steam coal), 3,900 tons, £840; Bellambi, 9,824 tons, £2,766; Coalcliff, 18,100 tons, £4,006; Corrimal, 111,583 tons, £33,474; Mount Pleasant, 69,253 tons, £20,830; Mount Kembla, 151,258 tons, £39,028; Metropolitan Helensburg, 228,341 tons, £64,255; Osborne Wallsend, Mount Keira, 78,652 tons, £18,573; South Bulli, 167,370 tons, £36,966; South Clifton, 50,000 tons, £10,900.

An Abortive Strike.—A curious instance of a strike in which the last state of the men was worse than the first is reported from New South Wales. The miners of Newcastle, in that colony, being on strike, were met by the employers with an offer which was declared to be the best that the circumstances of the case would afford. It was declined. By and bye they offered to accept it, but at this time matters had become so much worse that the masters lowered their offered wage from 3/- to 2/10. Mr. Reid (who acted as mediator) induced them to raise the figure to 2/11, and on that footing the men will return. They were getting 3/2 before the strike, and they went out on the advice of their leaders to force 3/6. After ten weeks' suffering they came back at 2/11.

In reply to an application by Scotch coalminers for an advance of wages, the coalminers of Fife and the Lothians state that the condition of trade does not justify such an advance.

An Ingenious Invention.—The spontaneous combustion of coal on ship board is attributed by Emanuel Stauber, of Hamburg, to a combination of causes, including the admixture of air and moisture with the gas exhaled by the coal, together with the heat generated by the internal friction of the heaps from the rolling of the vessel. This has led him to patent a method of ventilation having the threefold object of drying the coal, removing the evolved gases, and preventing the mass from moving about. His plan is to perforate the floor of the hold and to set up a pair of perforated walls down the centre, thus forming an air space in the form of an inverted T, which is connected with a double ventilating cowl on deck. In addition to the partition walls a number of movable perforated pipes are to run from the central shaft transversely through coal at different heights.

A Hydraulic Coal Tipper.—The port of Ruhrort is one of the largest shipping ports of coal in Germany, and in order to handle the material cheaply numerous labour saving devices have been introduced in the past few years. Recently a special hydraulic coal tipper was built, and it is one of the largest of its kind in existence. The principle of the apparatus is that the excess of power furnished at the time of filling is utilised to raise the empty truck. All coal or coke trucks in use on the railroads in the Kingdom of Prussia and Empire of Germany, the wheels of which are from 8·208 feet to 14·76 feet apart, which contain a load of from 10 to 15 tons, and possess any system of brake, may be placed on the bascule. They must, however, be furnished with a movable panel at the end. The bascule comprises a table which moves round a transversal horizontal axis. The front part is connected with a piston rod, which works in a cylinder containing water and communicating with an accumulator. In front of the table there is a large gullet. The coal truck having been conveyed to the bascule, strikes against two solid hooks, which clasp the front axle and hold it firm. The table commences immediately to incline and the coal falls through the opening of the panel into the gullet, and from thence into the boat. As soon as the truck is empty the table rises automatically. A regulating valve controls the working and permits of the table being stopped at any angle between 0 degrees and 45 degrees. The gullet placed at the end of the table embraces the entire width of the truck, it is furnished with two lateral panels so as to prevent the coal from escaping at the sides, and can turn round its fulcrum. A chain worked by two men in a cabin, which descends with the whole bascule system, regulates the fall of the coal. The starting lever of the valve of the cylinder is in the cabin last mentioned. This cylinder and the accumulator are inside a chamber in the stone or brick building. They are preserved from dust and from inrushes of water. Five men are required for the operation described, one to regulate the working of the table, two for the service of the gullet and placing and weighing of the wagons, the last two to render assistance. The movement of the bascule does not occasion any expense since no motive force is required. In ten hours from 120 to 150 trucks containing loads of from 10 to 15 tons can be tipped. The operations are entirely without danger, there being plenty of room to move around the truck. To prevent the water in the cylinder from freezing it is mixed with glycerine.

We wish to draw the attention of all competitors to the way they address their letters for the competitions in our paper. For some time past a large number have been forwarded to our publishers in London, Messrs. E. Marlborough and Co., instead of to us direct at Wigan. In future letters addressed to London will be refused. They should be forwarded to "Editor of *Mining*, Clarence Works, Wallgate, Wigan. We further wish to inform our competitors that letters received here understamped will be also refused. The letters can be sent at Book Post Rate if not sealed up, *i.e.*, with the flap simply turned in.

Steam Winches in India.—The Government of India have ruled that steam winches are chargeable with duty for whatever purpose they may be used.

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Useful Information Relating to Pumps.

By Philip R. Björling.

(Author of "Pumps & Pump Motors," "Practical Handbook on Pump-Construction," &c., &c.)

(Specially written for "Mining.")

WHEN we look at the quantity of water that has to be dealt with in collieries and mines we can easily see the importance of good pumping machinery and the necessity that all who have charge of them should clearly understand the construction of the pumps and the details of all the pit work. It is our intention in these articles to lay before our readers the principles upon which the pumps act, and give them theoretical and practical hints relating to the construction and management of them.

There are two ways in which force may be applied to water through the medium of pumps used in collieries and mines:—One being to bring the liquid upon a piston working up and down a cylinder, to the upper end of which a pipe may be fixed; the upward motion of the bucket then raises the water at every successive stroke until it eventually reaches the top of the cylinder or pipe. Pumps of this class are called "lift pumps," because the liquid is lifted up by the bucket to the required height. It is obvious that the height is limited only by the strength of the materials and the force available. In such a case atmospheric pressure is employed to raise the water a portion of the height. The part of the pump below the bucket is called the "suction," and that above it the "lift."

The second mode of applying force to the water by means of a pump consists in bringing the fluid beneath a piston working up and down inside a working-barrel, the downstroke of the piston forcing the water up through a pipe provided, or in any other direction that may be required. A pump of this description is called a "force pump," and possesses many advantages over the preceding one, which will be explained under the proper head.

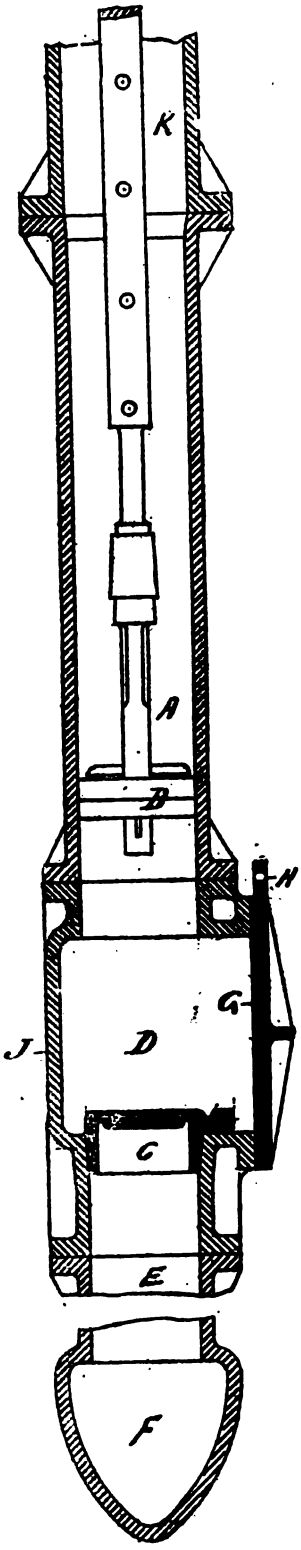

Fig. 1.

It will be easily understood that the water above the bucket and below the piston or plunger can be raised to any height required, but the height to which the water under the bucket or piston can be raised above the natural level of the water in the pit sump is limited by the pressure of the atmosphere. A column of air at the sea-level is 27801 feet, or nearly 5¼ miles high. Now the weight of 1 cubic foot of air at a temperature of 60 degrees Fahr. is = 0·076097 lbs., hence 27801 × 0·076097 = 2115·57 lbs. pressure per square foot, therefore:—

$$\frac{2115{\cdot}57}{144} = 14{\cdot}69 \text{ lbs.}$$

pressure per sq. inch, usually taken as 15 lbs. Again, water at 62 degrees Fahr. is 819·4 times heavier than air, consequently:—

$$\frac{27801}{819{\cdot}4} = 33{\cdot}928 \text{ feet}$$

height of a column of water corresponding with the pressure of the atmosphere. From this it will be seen that if the vacuum could be obtained perfect, there could not be more than 33·928 feet from the surface of the water in the sump to the bottom side of the bucket, piston or plunger, when it is at the highest point of its stroke.

We will now examine the action of an ordinary bucket pump, such as is usually adopted for the bottom pump in a pit shaft. This is illustrated in sectional elevation (fig. 1). It consists of a working-barrel, A, fitted with a bucket, B, which latter is furnished with a clack-valve opening upwards; C is the suction clack-valve secured in the clack-piece. Now, if the bucket is raised in the working-barrel by means of the wood spears, K, a partial vacuum is formed under it, more or less perfect according to the perfection of the working parts and tightness of the joints in the suction-pipe and the clacks. The clack-valve in the bucket is kept shut by the pressure of air above it, while the suction-clack will be forced upwards by the water rising into the working-barrel, the water being forced into the space, otherwise forming a vacuum, under the bucket, by the atmospheric pressure on the exposed surface of the

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water in the sump; in other words, by abstracting the pressure of air from part of the surface of the water, that portion of water under the bucket is forced upwards by the pressure in the remaining portion of its surface. Supposing the upstroke of the bucket completed, and the space under it filled with water, on commencing the downstroke the water cannot return through the suction-valve, for it shuts immediately by the weight of the water, but the bucket-valve will open by the same effort. Thus the water will be forced from the underside to the topside of the bucket. The shorter the suction-pipe is the more certain it is that the working-barrel will be filled at every stroke, and it should not be made more than 20 feet in length.

The quantity of water raised by a pump depends of course upon the diameter of the working-barrel, the length of the stroke of the pump, and the number of strokes per minute. According to the Board of Trade the standard weight of 1 cubic inch of water is 252·286 grains. One lb. avoirdupois = 7000 grains, and therefore 1 gallon weighing 10 lbs.

$$= \frac{7000 \times 10}{252{\cdot}286} = 277{\cdot}462 \text{ cubic inches.}$$

Hence a column of water 1 square inch in area, 27·7462 inches high, gives a pressure of 1 lb. per square inch; 27·7462 : 1 = 12 is to the pressure of a column of water 1 inch area and 1 foot high.

$$\frac{12}{27{\cdot}7462} = 0{\cdot}432 \text{ lbs.}$$

pressure given by a column of water 1 foot high and 1 inch area. This is usually taken 0·433, or practically 0·44. It follows that

$$\frac{27{\cdot}7462}{12} = 2{\cdot}3121$$

height of a column of water, in feet, to give a pressure of 1 lb. per square inch, usually taken in practice = 2·3.

The quantity of water delivered by a pump, of the double-acting type, will be found by the following fundamental rule:—

$$Q = \frac{A \times I}{277{\cdot}462} \quad \ldots \quad \ldots \quad (1)$$

and the area of pump required for a given quantity of water.

$$A = \frac{Q \times 277{\cdot}462}{I} \quad \ldots \quad \ldots \quad (2)$$

When A = area of pump in inches
Q = gallons of water delivered per minute
I = piston speed in inches per minute
277·462 = number of cubic inches contained in a standard English gallon

Now if we, in rule 1, take F = piston speed in feet per minute, instead of I, we get:—

$$Q = \frac{A \times 12}{277{\cdot}462} \text{ hence } \frac{277{\cdot}462}{12} = 23{\cdot}121$$

or say for the sake of simplicity 23, which is near enough for any practical purpose. Substituting this latter figure in rule 1 we get:—

$$\frac{A}{23} = Q,$$

the quantity delivered in gallons for 1 foot of stroke of the bucket or plunger.

Therefore:— $$Q = \frac{A \times F}{23} \quad \ldots \quad \ldots \quad (3)$$

and $$A = \frac{Q \times 23}{F} \quad \ldots \quad \ldots \quad (4)$$

The formula 3 can again be simplified by dividing 0·7854, which is the difference between the area and the square of the diameter of a circle by 23, thus:

$$\frac{{\cdot}7854}{23} = 0{\cdot}0341 = \text{say } 0{\cdot}034$$

hence we obtain by substitution:—

$$Q = D^2 \times 0{\cdot}034 \times F \quad \ldots \quad (5)$$

which is the formula mostly used by hydraulic engineers, on account of it being easier to square the diameter than calculating the area, when no tables of areas of circles are at hand; but if we wish to find the diameter of the pump required, the rule will be:—

$$D = \sqrt{\frac{Q}{0{\cdot}034 \times F}} \quad \ldots \quad (6)$$

In that case, if we have no tables of square roots handy, it is easier to find the area than the corresponding square root, especially as the result obtained will probably be a whole number and some decimals; in such cases the rule 4 will be handier.

A very useful approximate rule is obtained by slightly altering rule 1; if we take gallons per hour delivered by double-acting pumps:—

$$Q = \frac{A \times 12 \times 60}{277{\cdot}462} \text{ and } \frac{277{\cdot}462}{12 \times 60} = 0{\cdot}385$$

therefore:—

$$Q = \frac{A \times F}{0{\cdot}385} \text{ and } A = \frac{Q}{0{\cdot}385 \times F} = \frac{{\cdot}7854}{0{\cdot}385} = 2{\cdot}04$$

so that:— $$Q = D^2 \times 2{\cdot}04 \times F$$

from which is obtained the approximate rule:— *Square the diameter of the pump in inches and multiply by twice the piston speed in feet per minute; the result equals the quantity of water in gallons delivered per hour by a double-acting pump.*

Another approximate *rule* for finding the quantity of water delivered by a double-acting pump of a given diameter in inches is: Square the diameter of the pump in inches, the result being the number of gallons of water delivered per minute, when the piston, bucket or plunger, as the case may be, is moving at a speed of 30 feet per minute. To prove the correctness of this rule we will take the following *example*:—If we have a pump 9 inches diameter, then;—

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$Q = 9^2 \times 0{\cdot}034 \times 30 = 82{\cdot}620$ gallons per minute according to rule 5.

By the approximate rule, $9^2 = 81$ gallons per minute.

If we wish to obtain the diameter of the pump, and the gallons are given, we have only to extract the square root out of the number of gallons to be delivered per minute, if the piston speed is 30 feet per minute. In this case we must substitute 30 for F in rule 6, then we get:—

$$D = \sqrt{\frac{82{\cdot}620}{0{\cdot}034 \times 30}} = \sqrt{\frac{82{\cdot}620}{1{\cdot}020}} = \sqrt{81} = 9 \text{ ins.}$$

theoretically; by the approximate rule:—

$$\sqrt{Q} = \sqrt{81} = 9 \text{ inches diameter.}$$

In all the above rules the piston speed is taken the delivery stroke only—that is, one-half only of the actual speed of piston in single-acting pumps or only the upstroke of bucket pumps, and down-stroke of single-acting piston or plunger pumps. If the pumps are of the three-throw type, as mostly used for electric pumping, the quantity must be taken as three single-acting pumps or one and a half the quantity delivered by one double-acting pump.

The result of these rules is the theoretical quantity, to this must be added a certain percentage to allow for "slip"—that is, water returning through the suction-valve into the wind-bore before the valve has had time to close—also loss of water through leakage in pipe joints, cover joints, and stuffing-boxes, and glands. This percentage varies greatly according to the class and conditions of the pump; if it is working against a high or low lift, and the "slip" depending upon the class of valve used for the pump. For well-designed direct-acting horizontal pumps, 10 per cent. should be enough for ordinary purposes, but if the pump is old and badly designed, 25 per cent.; and in some cases, especially if clack-valves with high lift are used, 50 per cent. must be added to the total amount required.

We have now shown how to determine the diameter of the pump, but we must first settle the piston speed; this depends greatly upon circumstances. The water enters into the working-barrel at a velocity equal to that obtained by a body falling from a height of 33 feet, so that if we use the ordinary rule for falling bodies:—

$$V = \sqrt{2\,g\,s}$$

in which V = velocity in feet per second
s = space travelled through in feet
g = gravity = 32·2

we get in this case:—

$$V = \sqrt{64{\cdot}4 \times 33} = \sqrt{2125{\cdot}2} = \text{about } 46 \text{ ft. per sec.,}$$

and $46 \times 60 = 2760$ feet per minute.

So that if everything was perfect, and there was no friction of the water in the suction-pipe, clear water-way through the suction-valve made of large area, and all rods, etc., perfectly rigid, and quick reversal of the motor, we could easily use a piston speed of 800 feet per minute and even up to 1000 feet at an emergency. Direct-acting "Simplex" steam pumps run at from 100 to 200 feet per minute; ordinary "Duplex" steam pumps have a piston speed of from 150 to 250 feet per minute; Holehouse & Morley's patent "Duplex" pump from 300 to 600 feet per minute. Large Cornish engine pumps average a speed of 130 feet per minute, although they have been known to run for a short time at a speed of 280 feet per minute. A very good rule for the piston speed of large pumping engines is:—

$$P = \sqrt{L} \times 60$$

in which P = piston speed in feet per minute
L = length of stroke in feet
60 = a constant

The total pressure on a pump is of course found by multiplying the area of the pump in inches by the pressure of the head of water in lbs. per square inch. For example, if we have a bucket pump 10 inches in diameter = 78·54 inches area, and the water has to be lifted 200 feet = 86·00 lbs. per square inch, then:—

$78{\cdot}54 \times 86 = 6754{\cdot}44$ lbs. total pres. on the bucket.

(*To be continued.*)

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—R. Forster, 13, Newbottle Row, Houghton-le-Spring, R.S.O., Durham.

Commended.—W. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.; J. Jones, Pelydfryn, Aberderfyn, near Ruabon; W. G. Jones, Mill Terrace, Mason's Road, Gorseinon, near Swansea; J. Mann, 95, Oakenshaw, Willington, Durham; S. Chadwick, 601, Hindley Road, Westhoughton.

Question 2.—J. G. Bell, Evenwood, Bishop Auckland.

Commended.—W. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.; J. Gillispie, 384, Main Street, Maryhill, Glasgow; J. Mann, 95, Oakenshaw, Willington, Durham; J. E. O. Keefe, Amble, Northumberland.

Question 3.—W. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.

Commended.—J. G. Bell, Evenwood, Bishop Auckland; R. Forster, 13, Newbottle Row, Houghton-le-Spring, R.S.O., Durham; J. Jones, Pelydfryn, Aberderfyn, near Ruabon; J. Gillispie, 384, Main Street, Maryhill, Glasgow; W. H. Darling, Highlands, Stowbridge; W. G. Jones, Mill Terrace, Mason's Road, Gorseinon, near Swansea; J. Mann, 95, Oakenshaw, Willington, Durham; S. Chadwick, 601, Hindley Road, Westhoughton; J. Finch, Green Lane, Hindley Green; C. E. Scotney, 44, Byrom Street, Hucknall Torkard, Notts; W. Dunn, 20, Quarry Street, Hamilton, Lanarkshire, N.B.; T. Finch, Wigan Road, Standish; T. Wilkinson, Brancker Street, Over Hulton; J. E. O. Keefe, Amble, Northumberland.

Answers to Correspondents.

THOS. WATSON.—We are in receipt of your answer to "Aspira," on Steam Production. It is too late for publication this issue.

J. M. KAY.—Will appear next issue.

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The National Association of Colliery Managers.

THE annual conference of this Association was held at Wrexham from September 3rd to September 5th, under the presidency of Mr. Millington, of Hardman House, Hollinwood, Oldham. The ninth annual report was presented to the meeting, and stated that the council had had under consideration the question of the colliery managers to serve on juries. They were taking steps to get an exemption if possible, and with that object had been in communication with the Home Office. The council deeply regretted that the year had witnessed a long series of fatal disasters in mines. These disasters, however, had always one satisfactory feature—they invariably brought to the surface the latent heroism which seemed to pervade every coalfield. The careful attention of certificated managers was called to the Coal Mines Regulation Act of 1896, now in operation, the provisions as to the use of lights and explosives and as to the dangers of firedamp and coal dust demanding thoughtful consideration.

On September 4th, the report of the council having been adopted, on the motion of Mr. N. R. Griffith (Wrexham), Major T. H. Clayton, certified manager, and proprietor of the Brynmally and New Broughton Collieries, near Wrexham, was unanimously elected president, in succession to Mr. Millington, and the following gentlemen were elected vice-presidents:—Mr. Millington, Mr. Brain, Mr. James Tongue of Bolton; Mr. Edward B. Wain, of Norton-in-the-Moors, Stoke-upon-Trent; Mr. Isaac Jones, Ruabon; and Mr. Henry Palmer, Medomsley, Durham; Mr. P. Mehers, of Orrell Collieries, near Wigan, was appointed Treasurer, and Mr. William Saunders, of Derby, secretary.

Major Clayton, in returning thanks for his election, said that he much regretted that they were meeting when the coal trade generally was under a very black cloud, and that it had been found impossible to arrange terms for carrying on the Conciliation Board. It was a deplorable thing they could not arrange matters of dispute without recourse to strikes and all that followed in their wake. There could not be a doubt that the play forced upon the colliery owners by the men in 1892 had to a great extent been the primary cause of the bad times they had experienced since, and of course the deplorable stoppage in 1893 assisted in making the result more acute. This was felt most keenly in the Midland district, for in 1893 the North of England and South Wales relieved them of a considerable proportion of their trade. This was clearly proved by the trade returns. The North of England for January and February of this year increased its shipments by nearly 200,000 tons, whereas the output in the Midland district had decreased considerably. This was also borne out by the fact that the non-federated districts worked about half a day per week more than the federated districts during the past twelve months. It would also be well to notice that, although the output of coal for the whole country had increased last year by 1,383,837 tons over any previous year, the output from the West Lancashire and North Wales coalfields, which formed a very large portion of the federated district, had decreased to the extent of 917,300 tons. These facts should speak for themselves in a very startling way to those who were responsible for the present state of things in the Midland district. The return of coal exported for the first six months of this year, when compared with 1895 and 1894, was a warning to all connected with the coal industry, and went a long way to explain the reason of the present stagnation in the trade. We exported in 1894, 16,340,000 tons; in 1895, 15,063,126 tons; in 1896, 6,594,637 tons. They could not ignore the fact also that America had for the first time exceeded the annual output of this country. Another reason, undoubtedly, for the slackness in the coal trade was that the gas companies, through the uncertainty caused by the action of the men, and with the desire to create another market for their gas on account of the increased use of electricity in public and private buildings, had in many large centres offered to supply and erect, free of cost, gas stoves in all buildings within their district. This he considered one of the most serious points the coal trade had to fear. Respecting accidents, he was sorry to find there had been 55 more fatalities than in the previous year. The chief cause of most of the accidents was falls of coal and roof, and it therefore behoved all managers to look carefully into the question of spragging and timbering.

A hearty vote of thanks was passed to Major Clayton for his very practical address, on the motion of Mr. Brain, seconded by Mr. Samuel Alsop, of Codnor, Derby. Mr. Brain said that was the first time they had had a gentlemen in the chair who was both a proprietor and the holder of a first-class managers' certificate.

We have received from Messrs. John Davis & Son, Derby, a revised issue of Section A of their Catalogue, comprising all descriptions of Mining, Surveying, and Mathematical Instruments, Miners' Safety Lamps, Meteorological Instruments, &c. The catalogue is very well illustrated, many of the blocks being taken from photographs, which may therefore be regarded as accurate representatives. Among minor improvements in instruments we notice that Celluloid faces have been substituted for silvered metal for Anemometer and other dials, and the needles of the Miners' Dials have been treated with a dead black which facilitates the task of reading underground. The catalogue also contains many designs of Safety Lamps:—Marsaut, Bonnetted Clanny, Mueseler, Stephenson, Davy, &c., in which the new metal, Aluminium, is now extensively used in their construction. For the convenience of their foreign connection they have attached a cable code to the principal instruments and apparatus described in the catalogue, which will no doubt prove of service. The catalogue will be forwarded on application, as will also their Electrical Apparatus and Appliances Catalogue, Section "B."

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Lifting a Vertical Rising Main by Expansion*

By William Howe.

AN interesting application of steam has recently been twice made at the Clay Cross collieries† for the purpose of lifting a rising main. On January 25th, 1894, a branch pipe, the second from the bottom of a rising main 6½ inches in internal diameter and 720 feet in length, broke in the neck, Fig. 1, and it was necessary on account of the water in the mine to renew it with all possible speed at any cost. The fracture was temporarily repaired as early as possible to allow the pumps to work, but it was in such an awkward position that it could not be made to hold, and when pumping was resumed half the water escaped.

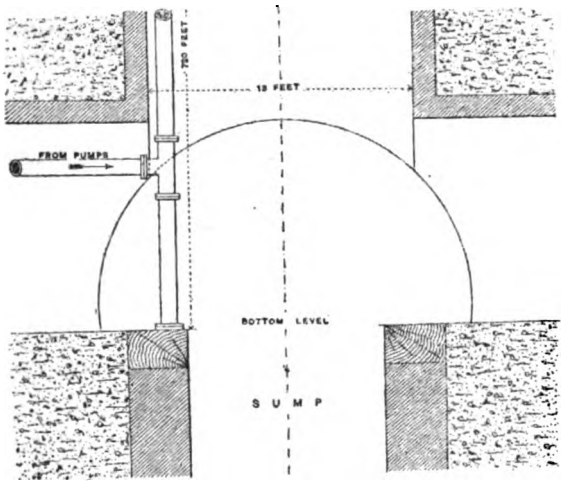

Fig. 1.

The author had three ideas about renewing the broken pipe, the first was to lift the main which was approximately 30 tons in weight by means of screws at the pit top, with chains or ropes suspended from them hanging down either side of the main, and secured at or near the pit bottom. Another plan was to lift it by means of screw or hydraulic jacks from the bottom, but he was very much averse to this, as in case of a jack failing the whole main would fall to the bottom, and loss of life would probably ensue. The third method was to take the pipes out from the top, and as the buntons were constructed and fixed in such a manner that the pipes could be easily taken out, it could be accomplished in forty-eight hours, it was therefore decided to adopt this plan, and arrangements were made accordingly.

However, on looking over some papers the author found a record of some experiments that he had made a few years previous with regard to the expansion of steam pipes in pit shafts, and the idea occurred to him why not empty the rising main, heat it by steam to expand it, then secure it in the pit shaft, shut off the steam, and when contraction commenced lift it from the bottom. The idea appeared feasible and perfectly safe, and he, with the consent of the manager, Mr. Jackson, immediately set to work to change the broken pipe by this method.

The first thing he considered was, at what height from the pit bottom would it be necessary to secure the main to allow of sufficient expansion and subsequent contraction to take out and renew the broken pipe; secondly, would the flanges and bolts of the main be sufficiently strong at that point to sustain the suspended load; and thirdly, what means should be adopted to secure the main after it was expanded.

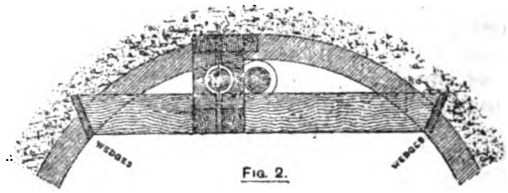

Fig. 2.

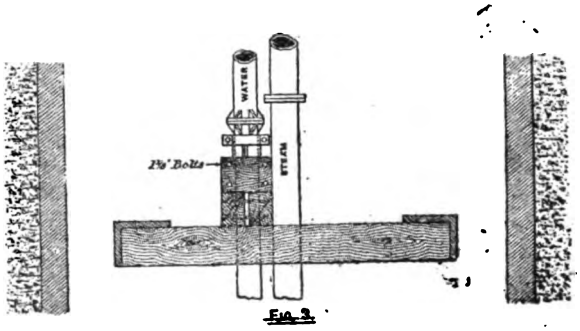

Fig. 3.

The main was supported laterally every 27 feet, it was free to more vertically, and, as the author has previousty stated, was 720 feet long. From experience he knew that at 180 feet from the pit bottom there would be an expansion of 2½ to 3 inches, the bolts, pipes, &c., were sufficiently strong to carry the suspended weight of 9 to 10 tons, and the brickwork in the shaft was particulary well adapted to fix in a bunton to carry the load, so he decided to secure the main at this point.

A pitch pine baulk 14 inches square was let into the brickwork 15 inches at each end close to the body, and 3 feet below the flange of a pipe in the main, and securely wedged in, as shown in Figs. 2 and 3. A steam pipe, ½ inch in diameter, with a regulating valve, was connected from the steam pipes to the rising main at the pit-bottom. One pair of wooden, and two pairs of iron clamps to grip the main, and two cross buntons, one end

* From Paper read at a Meeting of the Midland Institution of Mining Engineers. † Engineer, 1894, vol. lxxvii., page 112.

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of each to rest on the main buntons, and the other to rest on a pad in the brickwork behind the main, were got ready during the night, and by 8 a.m. of the following day all the tackle was fixed ready for changing the pipe. The clamps, as shown in Figs. 2 and 3, were fixed loosely so as to waste as little time as possible, the pumps were stopped, the main emptied, and steam turned on, and in an hour's time the main had expanded 2½ inches at the point for securing the same, the author thinking this sufficient (though it would have expanded still more), had it thoroughly well secured by the clamps and steam shut off. The main being open at the top and bottom, immediately began to cool and contract, and in less than ½ hour the new pipe was introduced, steam again turned on until the main was sufficiently expanded to have the clamps taken off, steam was then shut off, and the connection made to the pumps. The time from first turning on the steam, including changing the pipe and again starting the pumps, was only four hours, and not a single hitch occurred in the whole proceeding.

In the second case exactly the same means were adopted with a similarly successful result.

The process is simple, free from all danger with ordinary care, expeditious, and of much less cost than any other method known to the author, consequently he has taken the liberty of placing it before the Institution thinking it might be of service to its members under similar circumstances.

Coal Mining in India.*

The Warora Colliery.

This colliery is situated in the Central provinces and is owned by the Government of India.

Ventilation.—This is one of the few mines in India where a proper and systematic attempt is made to ventilate the mine in a way that should ensure a constant and adequate amount of ventilation passing through all parts of the mine. The principal ventilating apparatus consists of a Waddle fan running at about forty to forty-five revolutions per minute. It is 30 feet diameter, and there are two steam engines for the purpose of working the fan, one engine only being used at one time. The engines are changed monthly, and the fan is stopped as a rule for about one and a-half hours every Sunday morning for the purpose of examination, cleaning, &c. There are three boilers, but only two are worked at one time. There are twelve wooden air-doors, the standard size of which is 6 feet by 4½ feet, and fifty-three brattice sheet doors. Also eight brick and timber air-crossings, 299 ventilation or ordinary brick stoppings, and 63 sheet ventilating stoppings. There are boys to attend to all the wood doors.

* From Mr. Grundy's H.M.I.M. Report.

Persons Employed.—At the time of Mr. Grundy's visit there were 1,583 persons employed at the mine, 889 being employed below ground and 694 above ground. Females are not employed or allowed to go below ground at this mine. The youngest male below ground was supposed to be at least twelve years of age; and the youngest employé above ground was ten years of age. In addition to the foregoing employés, there were 250 persons—135 males and 115 females—employed at an excellent and valuable brick and tile works adjacent to and connected with the mine. The mine is worked in three continuous shifts of eight hours each; but the employés above ground work ten hours per shift.

Haulage.—Another feature that is almost unique in India is an excellent endless rope haulage system from the dip workings. The tubs are connected to the rope quickly and easily at any part of the incline by Rutherford and Thompson clips. The tubs travel singly, each separate tub being clipped directly to the rope, and all the full tubs are automatically disengaged at the top of the incline. This system of haulage is working very smoothly and successfully, and appears to be capable of being extended to almost any distance, and to economically convey a large output from the dip workings.

Lighting.—The manager of this mine has been trying the use of an adaptation of a simple form of storm lamp with the object of being able to burn kerosine oil without the very great disadvantage of the volumes of soot and smoke that are given off when it is burned in the open lamps ordinarily used at mines in India.

Blasting Powder.—Another practice at this colliery that might be adopted with many advantages at other mines is that of regularly testing the strength of samples of all the country blasting powder submitted for purchase. It is regularly tested in a specially-constructed apparatus, and the strength required of it is that one-half drachm should raise a ball weighing 26½ lbs. for from 20 to 25 inches. This is equivalent to half a drachm doing 44 to 55 foot-pounds of work.

Weighing and Screening.—All the coal raised at this mine is weighed in the tubs as soon as it leaves the cage, and the coal is then tipped directly on to the screens, along which it passes at once into the railway wagons. There is no putting down of the coal on to the floor, lifting it up again, carrying it about, and then hand-screening it, that is so common at Indian mines as if they were afraid to part and did not want to let it go from the colliery. At this mine the coal has only been on the surface for a few seconds when it has been weighed, screened, and is landed in the railway wagons. The same principle prevails below ground, for in a great many working places in the mine the coal is shovelled at once into the iron tubs, directly from the working face where the coal is made to fall from the whole coal.

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Federated Institution of Mining Engineers.

THE Seventh Annual General Meeting of this Institution was held at Cardiff this week. After visiting the exhibition the members assembled at the rooms of the South Wales Institute of Engineers on Tuesday, when a number of papers on mining and kindred subjects were read and discussed. Mr. G. A. Mitchell (Glasgow) presided, and there was a large attendance.

The Secretary (Mr. M. Walton Brown) read the Annual Report of the Council which congratulated the associated institutes on the success which had attended the federation. The total membership was now 2,380.

The Report of the Treasurer (Mr. Reginald Guthrie) showed the financial position of the Institution to be satisfactory.

THE PHENOMENA OF COLLIERY EXPLOSIONS.

Mr. Donald M. D. Stuart, read a paper on the phenomena of colliery explosions. He said that notwithstanding the precautions which experience and science had devised, explosions still occurred in the best arranged collieries, showing that there were some phenomena not yet fully recognised and understood. He had had the advantage of investigating the first and second recorded explosions in mines that yielded no fire-damp, viz.:—the disasters at the Camerton and Timsbury collieries, Somersetshire, in November, 1893, and February, 1895, respectively. These disasters provided opportunities for observing the phenomena of two explosions not complicated by the presence of fire-damp. They exhibited the effects produced by an explosive agent, and therefore pronounced its identity as every agent is identified by the phenomena it produces. The records had this value: they demonstrated that explosions were produced in mines by gases derived from coal-dust, and that the processes were originated under ordinary working conditions and operations; they also disclosed the phenomena which identified explosions from this agent. The writer then proceeded to give in detail the local conditions under which these explosions had occurred, and the theory he advanced upon his records and investigations may be shortly stated as follows:—A colliery explosion, in which coal-dust is the principal agent, comprises numerous local explosions, separate in time and in space, at irregular intervals, where the available supplies of atmospheric oxygen are greatly increased, and caused by the explosive combustion of hydrogen derived from the coal-dust in the antecedent spaces, by a series of chemical actions, of constant sequence, which produce heat for regeneration without auxiliary intervention, and are constantly reproduced along the path of the coal-dust under the conditions named. This theory accounts for the coked residues of coal, and the positions in which they were found; explains the presence of amorphous carbon in atmospheric suspension, and its characteristic deposition upon the enclosing walls throughout the fields of disaster; accounts for the practical absence of carbon monoxide and carbon dioxide in the gaseous products; supplies the heat for the distillatory action, for dissociation, for raising the air of the gaseous mixture to ignition-temperature, and for supplementing the losses due to the contact of the products of combustion with cold surfaces; allows time for the distillation of coal, and the chemical changes in the series of actions; provides the explosive gas for producing the disruptions; explains the occurrence of the disruptions at intervals, the absence of mechanical effects in the intervening spaces, the conditions under which propagation proceeds or is arrested, the maintenance of the mechanical equilibrium of the air-current at Camerton collieries, and excludes no coal—except that which yields no combustible gases when subjected to the temperature of destructive distillation.

ANTHRACITE COAL IN SOUTH WALES.

Papers on this subject were submitted by Mr. Morgan W. Davies and Mr. W. D. Wight; the latter gentleman pointed out that while the production of anthracite coal in the United States had rapidly increased to a total of 58,000,000 tons in 1895, the anthracite deposits of South Wales were comparatively neglected, although it was estimated that no less an area than 410 square miles contained numerous seams of anthracite coal of excellent quality, and of more than average thickness, easily reached in many cases by day-drifts. It was difficult for those who had not had experience with this class of coal to understand that, although of the finest appearance and purest quality, yet it was nearly impossible to burn it in the ordinary grates usually found in dwelling-houses, but with specially prepared grates it could be burned with economy and efficiency. Experience had shown that the size of coal usually called "nuts" was the most suitable for domestic stoves, and a plant had been erected at Glyncastle colliery designed to manufacture this size, the remaining sizes being only incidentally produced.

The writer then proceeded to describe the plant in detail, and the analysis of the Glyncastle coal is given as follows:—

Carbon.....	91·67 per cent.
Hydrogen	3·93 ,,
Oxygen	1·87 ,,
Nitrogen	0·44 ,,
Sulphur	0·77 ,,
Ash	1·32 ,,
	100·00

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AUTOMATIC VARIABLE EXPANSION-GEAR APPLIED TO BALANCED SLIDE-VALVE ENGINES.

Mr. W. D. Wright described a gear which had been designed to provide with slide-valves an automatic cut-off, as perfect as could be attained by the use of Cornish or even Corliss valves.

SECONDARY HAULAGE.

Mr. W. Galloway read a short paper on the cost of secondary haulage, *i.e.*, the collecting of coal from the working places, and its removal to sidings from which it might be conveniently taken away by the main system of haulage adopted. The operation was usually carried out by boys or men, and ponies, and from the nature of the work was necessarily more expensive per ton per unit of distance than the primary haulage on important horse-ways and engine-planes. At one of the Llanbradach pits (where the general inclination of the seam was about 1 in 24) this haulage had been done exclusively by means of small self-contained semi-portable engines worked by compressed air, and a table of costs, which accompanies the paper, shews that the cost of hauling coal 300 yards was 2·65d. per ton. The writer suggested that it would be interesting to compare these figures with those of other collieries having similar gradients and employing other means of haulage. If the weight of rubbish hauled could be ascertained, the comparison would be all the more useful.

An exhaustive geological paper on "Possible extensions of the coalfields of France," by Mons. Gergeron (translated by Mr. L. L. Belinfante) was communicated, and the following papers were also submitted:—"Compound winding-engine at the Great Western Colliery Company's Tymawr Pit: with notes on its comparative steam economy," by Mr. Hugh Bramwell; "The principal pumping-engine at Llanbradach Colliery," by Mr. Wm. Galloway; "Roman iron and steel making in Great Britain," by Mr J. Storrie; "The Lake Superior iron ore region," by Mr. Horace V. Winchell; "Mining in North Argentina," by Captain C. C. Longridge; "Gold extraction," by Mr. John Yates; "The geology of Africa, in relation to its mineral wealth," by Mr. Walcot Gibson.

The meeting was continued on Wednesday by visits to the Ocean Coal Company's Deep Navigation Collieries, and on Thursday the Dowlais Steel Works were inspected.

Correspondence.

Sir,—The question I am about to ask will perhaps be rather novel to some of our readers, but I have seen no reliable answer to it, viz.:—"What service or practical use are Science and Art Department Mining Certificates?" I myself possess them, but find them of little service as I am unable to enter for a Colliery Manager's Certificate, owing to not having five years' practical experience, although I have little doubt as to result of exam. if I entered. Will these certificates obtain me a situation as fireman or deputy under the under-manager or are they practically useless? An answer from any of your readers will greatly oblige. ARETHUSA.

Prize Essay.

In lieu of the Competition Questions an award of 10/- will be made for the best "DESCRIPTION OF AN UNDERGROUND HAULAGE SYSTEM." Suitable sketches must be made to illustrate the article. Envelopes to be marked "ESSAY," and to reach us before October 2nd, 1896.

Haulage Ropes.—Method of Calculating Friction.*

BY C. F. SCOTT.

EARLY in 1893 I had occasion to ascertain the working load upon a hauling rope, and experienced considerably difficulty in obtaining a rule or formula applicable to the peculiar arrangement by which the rope worked. The following are a few of the particulars:—

Average weight of full tub	...	14½ cwts.
No. of tubs in a set ...	28	...
Total weight of set 14·5 × 28	...	20·3 tons.
No. of bottom rollers ...	23	...
Binding sheaves	5	...
Binding down sheaves ...	2	...
Curve ,, ...	10	...
Bell ,, ...	1	...

Heaviest gradient 1 in 13·3 for 305 yards.

I had to allow, in the absence of any direct rule, for the friction on the various sheaves and rollers, square turn, and heavy drift, down which the rope worked to reach the bottom seam. This allowance I put down as:—

Full load	406	cwts.
Say $\frac{1}{82}$ for friction	4·95	,,
	410·95	,,
Say friction on rollers, sheaves, &c.	1·22	,,
Total ...	412·17	,,

Heaviest gradient, 1 in 13.

$\frac{1}{13}$ of 412·17 = 31·7 cwts.

Working from these details, and taking the average of three authorities and sundry rope-makers' approximate rules, the working load worked out to 29 cwts. I was not satisfied with these results, and determined to obtain, if possible, some direct information upon the point by asking the question through the columns of the "Practical

* From the Journal of the British Society of Mining Students.

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Engineer." I was successful, and thinking the information might be useful to other members of this Association, my friend, Mr. F. Eastmead, of 39, Victoria Street, Westminster, gave me, most cordially, permission to publish in the "Journal" the calculations he made for me. I may say here that he had made several experiments to ascertain the friction ropes would have to overcome in travelling round sundry pulleys necessary to work the hydraulic lift in the Blackpool Tower, which he erected. The following is the paper he so kindly sent me:—

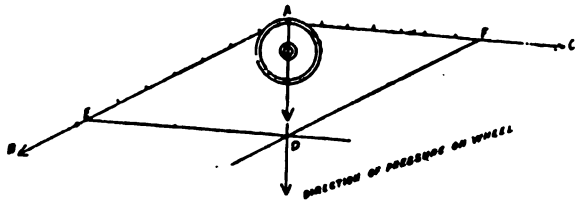
The loss of work due to the friction of the spindle is found by multiplying the pressure on the wheel P by the coefficient of friction—U.

Thus, loss $= P \times U$.

The equivalent pull on ropes is found by dividing this by the ratio between the pulley diameter and spindle diameter.

This extra pull on rope due to friction $= \frac{P \times U}{\text{ratio}}$

The pressure on wheel is found as follows:—Set out AB and AC representing the angle made by the rope. Mark off AE and AF to any scale, say 1 inch = 1 ton, representing the pull on the rope. Draw FD parallel to AE, and ED parallel to AF; then AD represents to the same scale the pressure on pulley (add to this the weight of wheel itself, when spindle is horizontal).



The loss of work due to bending a rope round a pulley may be taken, if the rope bends half round the pulley, thus: to be 15 lbs. for every ton load in each end of the rope; if P and P be each 1 ton, a weight of 15 lbs. must be added to P to make it go round (neglecting spindle friction).

I allow a factor of safety, myself, of 10 to 1 for ropes (direct winding) and make the pulley diameter = 19 times the circumference of rope.

(A) The coefficient of friction U is taken as ·15 of the pressure on spindle.

28 coal tubs at 14·5 cwts. = 406 cwts. = 20·3 tons
Assumed weight of rope ... ... ·4 ,,
20·7 ,,

So, for calculation we shall take pull on rope to be

$\frac{20·7}{13} = 1·59$ tons, or 3560 lbs.

(B) We may assume that the rope lies on the 50 bottom rollers with just pressure enough to drive them; in this case there is no loss from bending the rope, but assuming weight of roller to be 56 lbs., we may take the pressure on the spindle to be 60 lbs.:—

Ratio of roller diam. to spindle diam. $\frac{7·5}{6} = 1·25 : 1$

Extra pull on rope due to friction..... $\Big\} = 50 \left(\frac{60 \times ·15}{1·25}\right) = 360$ lbs.

(H) The 6 drum sheaves have a pressure of, say—
Pull on rope × ·1 = ·159 tons = 356 lbs.

Ratio of drum diam. to spindle diam. $\frac{17}{1·75} = 9·7 : 1$

Extra pull on rope $= 6 \left(\frac{356 \times ·15}{9·7}\right) = 33$ lbs.

(I) Upright sheave.
Pressure, say = same as $H = 356$ lbs.

Ratio $= \frac{8}{1·5} = 5·33 : 1$

Extra pull on rope $= \frac{356 \times ·15}{5·33} = 10$ lbs.

(C) Pressure = say pull on rope × ·27 = 356 × ·27 = 960 lbs.

Ratio $= \frac{46}{2·5} = 18·4 : 1$

Extra pull on rope $= \frac{960 \times ·15}{18·4} = 7·84$ lbs.

(D) Pressure = 3560 × 1·41 = 5040 lbs.

Ratio $= \frac{46}{2·5} = 18·4 : 1$

Extra pull on rope $= \frac{5040 \times ·15}{18·4} = 41$ lbs.

(G) Pressure = same as $D = 5040$ lbs.

Ratio $= \frac{34}{2·5} = 13·6 : 1$

Extra pull on rope $= \frac{5040 \times ·15}{13·6} = 55·6$ lbs.

(F) Pressure = load × ·27 = 3560 × ·27 = 960 lbs.

Ratio $= \frac{28}{2·5} = 11·2 : 1$

Extra pull on rope $= \frac{960 \times ·15}{11·2} = 12·85$ lbs.

(E) Load same as $F = 960$ lbs.

Ratio $= \frac{64}{3·5} = 18·3 : 1$

Extra pull on rope $= \frac{960 \times ·15}{18·3} =$ say 8 lbs.

Frictional losses deduced to their equivalent pull on rope:—360·00 + 33·00 + 10·00 + 7·84 + 41·00 + 55·60 + 12·85 + 8·00 = 528·29. Weight of tubs = 3560·00.

∴ 528·29 + 3560·00 = 4088·29 lbs. = 1·83 tons.

LOSS DUE TO BENDING ROPES.

If we take the work done in bending the ropes partially round the sheaves in the system as equal to bending half round three sheaves, we shall be about right. Load on ropes = 1·83 tons.
Loss at 15 lbs. per ton—

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$= 3\left(\frac{1{\cdot}83 \times 15}{2240}\right) = 3\ (\cdot0122) = \cdot0366$ tons, say $\cdot04$

So total load on rope $= 1{\cdot}83 + \cdot04 = 1{\cdot}87$ tons.

Breaking strain for machine winding should be seven times working load $= 13{\cdot}09$ tons, say a 2-inch patent steel rope by Cradock, which gives 14·5 tons. The result shews the weight I assumed for the rope to be too great; 16 tons would be nearer the mark. This, however, will make very little difference to the ultimate result.

The following are the formulæ for a rope passing over a pit-head winding pulley:—

Let w = weight of cage and tubs in tons.
" W = weight of rope "
" fr = frictional loss in spindle "
" fb = loss due to bending rope "
" R = ratio between pulley dia. & spindle dia.

Then—

$$fr = \frac{2\ (w+W) \times \cdot15}{R} = \frac{\cdot3\ (w+W)}{R} \quad \ldots \quad (1)$$

$$fb = w + W + fr \times \frac{15}{2240} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

or, putting in the value of "fr" just found in (1)

$$= w + W + \frac{\cdot3\ (w + W)}{R} \times \frac{15}{2240} \quad \ldots \quad (3)$$

So pull on rope on engine side of pulley $= w + W + fr + fb$. If there is a binding pulley at the bottom also—pull $= w + W + 1{\cdot}75\ (fr + fb)$.

Take the load to be lifted plus an assumed weight of rope. The load on pulley spindle will be twice this; so calculate the frictional loss as shewn on page 262. Then add this frictional loss (or "extra pull" due to friction) to the loads (cage, etc., and ropes). This will give you the pull on the engine side of the pit-head pulley. Then for each ton of this pull, add 15 lbs., which is "extra pull" due to the stiffness of the rope, and you have the total pull on rope. For direct winding you should take a rope giving a breaking strain ten times this load.

Putting this concisely we have:—

Pull on rope = cage and tubs + rope + frictional loss + loss due to bending.

Frictional loss reduced to a pull on rope:—

$$\frac{2\ (\text{cage and tubs} + \text{rope}) \times \cdot15}{\text{Ratio}}$$

Loss due to bending (*this comes out in tons*):—

$$\underset{\text{(in tons)}}{\text{Cage \& tubs}} + \underset{\text{(in tons)}}{\text{rope}} + \underset{\text{(in tons)}}{\text{frictional loss}} \times \frac{15}{2240} \text{ tons.}$$

If there is a binding sheave at the bottom too—

Pull on rope = Cage and tubs + rope + 1·75 (frictional loss + loss due to bending).

It will be seen that Mr. Eastmead's total load on rope is much higher than mine; this will be accounted for by his—

Assumed weight of rope being higher...in *A* equation
50 bottom rollers against my 23, and the assumed weight of each at 56lbs., } in *B* "
whereas the actual weight is 18 lbs.

These differences are, however, of no moment, as it is not for accuracy of figures, but rather for the value of the equations that Mr. Eastmead' paper is useful.

Answers to Competition Questions.

GIVEN IN No. 19, VOL. IV.

BLASTING.

(1) How many lbs. of gunpowder will be necessary to drive a tunnel 50 yards long, 10 feet by 6 feet, 10 yards of which is in hard white rock and the rest moderately hard blue metal?

Answer.—First find the cubical quantity of rock to be excavated:—

Length of tunnel = 50 × 3 = 150 feet.

Sectional area of tunnel = 10 × 6 = 60 sq. feet.

Then cubical quantity = 150 × 60 = 9000 cu. ft.

Of this quantity 60 × 10 × 3 = 1800 cubic feet is in hard white rock, and 60 × 40 × 3 = 7200 cubic feet is in moderately hard blue metal.

1 lb. of gunpowder will blast out about 10 cubic feet of hard white rock, or 30 cubic feet of hard blue metal.

Then $\frac{1800}{10} = 180$ lbs. of gunpowder to blast first 10 yards, and $\frac{7200}{20} = 360$ lbs. of gunpowder to blast remaining 40 yards.

180 + 360 = 540 lbs. of gunpowder required.

R. FORSTER.

METHOD OF WORKING.

(2) Two seams of coal dipping one in three, the upper seam 2 feet 9 inches thick, and lower seam 3 feet 4 inches thick, vary in distance from 3 feet 6 inches to 9 feet apart. The roof over the top coal is strong black bass, the strata between the seams is strong warrant and fireclay, and the floor of the lower seam is strong fireclay. Describe, with sketches, the method you would adopt in working these seams.

Answer.—The most safe and practical way would be to work both seams by a system resembling bord and pillar and longwall. I would drive three roads from the shaft direct to the dip, and out of these drive a pair of levels right and left (fig. 1.)

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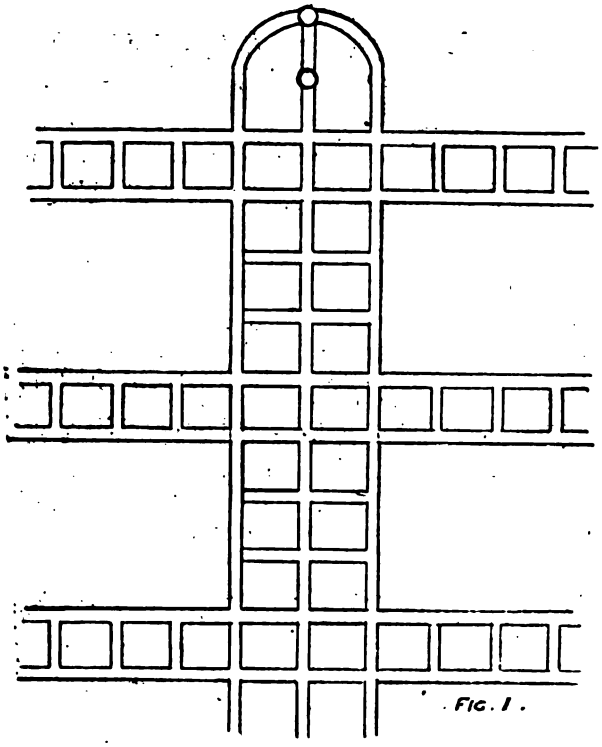

FIG. 1.

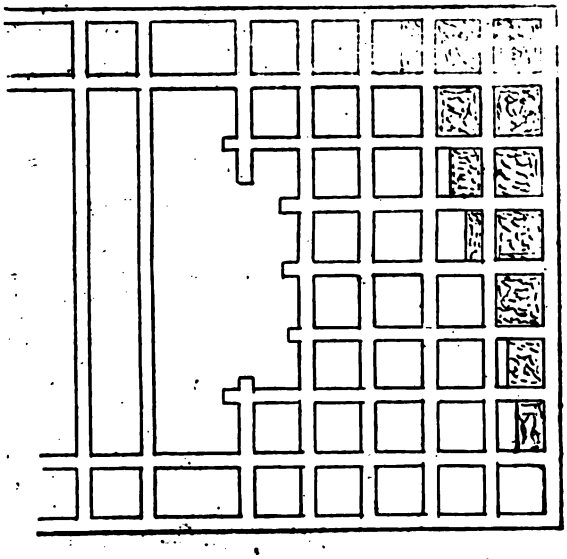

FIG. 2

Each pair of levels is separated by 300 yards of coal, which is left solid until the levels reach the boundary. I would drive small drifts through from the bottom to the top seam whenever convenient for transit of coal and ventilation, and have all the haulage done in the bottom seam. After the boundary was reached I would connect two sets of levels and split up the coal between them into square pillars by a series of drivages at right angles to each other, and commence to remove the pillars

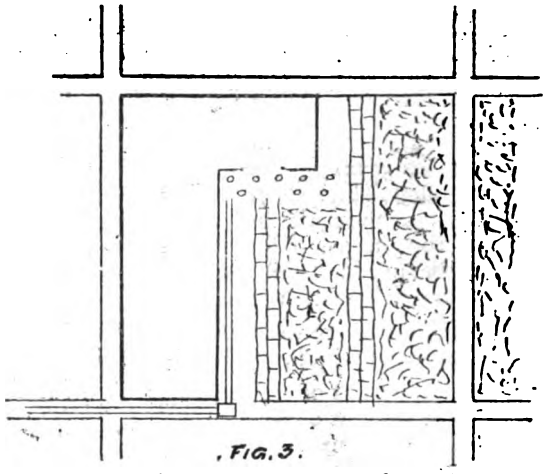

FIG. 3.

as soon as a sufficient number were formed, keeping the whole workings about three pillars in advance of the broken (fig. 2), and keep the top seam a little in advance of the bottom seam. I would have the pillars removed by lifts from 12 to 15 yards wide taken uphill, with the line of rails next the solid coal, and a packwall built on the other side, and support the roof at the face by two rows of chocks and props (fig. 3). If the fireclay formed the roof of the bottom seam we would be able to work the coal and clay together at the same time, as the clay would fall behind in the goaf and could then be filled up and between the chocks.

J. G. BELL.

DEFINITION OF THE TERM "THE WEIGHT ON COAL."

(3) What is meant by having "the weight" on the coal, and what practical use is made of it? How is the weight increased or decreased?

Answer.—By having the weight on the coal is meant the leverage that is exerted on the face of the coal due to the weight of the superincumbent strata as it settles down behind the working face. This weight is made practical use of when the coal is hard and difficult to get, or when the coal is being worked on end, when often, if the face of the coal is holed or kirved overnight, this weight is sufficient to bring it down, or at least to break it so that it falls immediately on taking out the spraggs, thus saving the miner much labour and enabling him to produce more round coal at a less cost. This weight is increased or decreased according to whether the roof be kept intact on the gobs and cogs, or whether it be left to fall behind the working face. If we wish to increase the weight we build good strong cogs and packwalls, and stow the gob with rubbish well up to the working face. If we wish to decrease the weight we leave the goaf empty, build a double row of cogs behind the face, and by withdrawing back timber break the roof down in the gob, thus taking off the leverage. WILLIAM SLOCOMBE.

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Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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Editorial Notes.

A NEW LIME CARTRIDGE.—A new form of lime cartridge, devised by B. J. Jarolimek, of Prague, is to be used in the dusty and gas-charged mines of Bohemia. The explosive charge is primed with quicklime, which is practically tamped with water. The heat of the slaking lime is said to be sufficient to detonate the charge; and it is claimed that the water and lime together effectually prevent any flame or dangerously heated gases from reaching the atmosphere or dust of the mine. An arrangement to regulate the flow of water to the lime varies the period of explosion and causes the lime to act as a time fuse.

ANOTHER SAFETY LAMP.—A novel safety lamp now used in German mines can be lighted without being opened. It is not closed in any special way, like other lamps, but its wick is provided with a cap that is forced down by a spring —instantly extinguishing the light—if it is opened.

PUMPING COALDUST.—An attempt has been made to pump coaldust from the Pennsylvania bituminous mines to the coast, and is reported on as giving favourable results. An American contemporary says:—An experimental plant has been erected at the Bower Hill Mine on the Panhandle railroad, about 12 miles from Pittsburgh. It has a line running from the pump-house to the mine. The coal and water are pumped into a basin, the water runs away and the coal settles at the exact spot it is forced out. The pipe is 3 inches in diameter and 1,500 feet long. At several points it is made to rise perpendicularly, and all sorts of bends, shapes, and twists have been put into the pipe to prove that nothing will stop the flow. Even when the pump is stopped the dust does not run to the lowest point in the pipe in an upgrade. Common bone-grinding machinery is used to pulverise the coal. It is first shovelled or dumped from the slack pile into a shute leading to a disintegrator. The coal comes out of this about $\frac{1}{16}$ths of an inch in size. It is raised to a second disintegrator which grinds it to dust. The stuff is again elevated and run through jigs, when the sulphur, slate, and impurities are removed. The combustible matter is drawn into a tank of water which has a mixer at the bottom, only allowing a certain quantity of coal to pass through the water. The best results have been obtained by pumping 65 per cent. of coal and 35 per cent. of water. With 30 lbs. pressure the mixture has been pumped the entire 1,500 feet, part of the distance at an angle of 45 degrees With 60 lbs. pressure it has been pumped around and shot into the air a distance of 100 feet.

COAL MINING IN OHIO.—The annual report of Mr. R. M. Hazeltine, I.M. Columbus, Ohio, U.S.A., for the year 1895, has now been issued. The year's production of coal was 13,683,879 tons, an increase over the preceding year of 1,773,660 tons. Of this 3,120,456 tons were mined by machinery. The average time worked was 156 days. 447 hands were employed in operating the machines, and 3,374 hands in blasting down and loading the coal after it had been undermined by the machines. There are 31 mines in the State equipped with machines; 82 machines are operated by electricity and a like number by compressed air. There are 1,187 mines, the number of persons employed being 28,998. There were 271 accidents, 52 of which were fatal, an increase of 7 as compared with the preceding year.

THE BRANCEPETH EXPLOSION.—As will be remembered this explosion caused the death of 20 persons on April 13th. Parliamentary reports have now been issued on the circumstances attending the explosions, and Mr. R. Donald Bain, H.M.I.M., in his report concurs with the verdict of the coroner's jury: "That a shot was fired, but by whose hand or under whose orders are unkown, and that this ignited the coaldust and caused an explosion in the cross-cutway." He also points out that the lesson to be learned is that the use of gunpowder on main haulage roads is attended with considerable risk and danger, and that to ensure safety in a dry mine none but high explosives should be used. Mr. J. Edmondson Joel, barrister-at-law, in his report states he is unable to say that either the C.M.R.A. of '87, or the general rule 12 of that Act has been contravened, or that the special rules of the colliery have been disregarded. Whatever absence of precaution was involved in the conduct of the men who did fire the shot, the responsibility must with the breach of authority, be taken together as resting on someone not a living person, and certainly not a responsible person having authority from the owners.

THE MICKLEFIELD COLLIERY EXPLOSION.—Mr. Harold Thomas, barrister-at-law, in his report on the circumstances attending the above explosion which occurred on April 30th, and in which 63 lives were lost, concludes that the explosion was caused by firedamp coming in contact with a naked light and exploding, and thus igniting coaldust which propogated the explosion. That naked lights ought not to be used at this colliery, and that further precautions than those adopted prior to the explosion should be taken to avoid dangers arising from coaldust; also that no prosecution should be instituted against anyone in respect of the explosion.

NEW GRIMETHORPE COLLIERY, YORKSHIRE.—The Yorkshire and Derbyshire Coal and Iron Company, Limited, has purchased the new colliery which is being sunk at Grimethorpe. It is expected to reach the Barnsley seam in twelve months, and arrangements are being made to raise 2,500 tons per day. The coalfield is 3,000 acres in extent. Two 19 feet shafts are being sunk, and 300 men are at present employed.

PREVENTION OF ICE FORMATION IN DOWNCAST SHAFTS.—A novel method of preventing the formation of ice in downcast shafts has been tried in Nova Scotia, and was described by Mr. A. Dick, in a paper read before the Canadian Mining Institute. The difficulty is obviated by allowing the air to travel through the workings in a given direction by an exhausting fan. By suddenly changing this to a blowing fan, the air is reversed in the shafts, and thus the downcast shaft is kept warm.

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The Sinking of the Dowlais Cardiff Colliery.*

By Mr. Henry Martin, M. Inst., C.E.

SEVERAL new and deep pits have been sunk in this district during the past few years, and in some cases, where the quantity of water met with has not been excessive, although the work has been carried out by the old system of hand-boring, it has been done rapidly. The Universal Company's new pits in the Aber Valley, and the Gilfach Company's pits in the Ogmore Valley, are examples of rapid sinking. The former Company sunk one pit 650 yards deep, and 18 feet 6 inches diameter in the clear, walled throughout with brickwork of a minimum thickness of 9 inches, in twenty-six months and three weeks. The latter Company sunk and walled one pit, 18 feet 6 inches diameter in the clear, to a depth of 534 yards in sixteen months, and another of the same diameter 600 yards in nineteen months and one week. Under my own supervision at Aberdare Junction, the Dowlais Iron Company have sunk two pits to a depth of 740 yards. They are 65 yards apart centre to centre, and each 20 feet diameter in the clear, lined with brickwork of a minimum thickness of 12 inches, laid in mortar made of Aberthaw lime, burnt on the site, gauged with boiler ashes in the proportion of one of lime to two of ashes. The first 34 yards was sunk through alluvial deposit consisting of sand, gravel and boulders. Water was met with in each pit 9 yards below the surface, which increased to 60,000 gallons per hour until walled back in both pits by watertight brick walling in cement 3 feet 2 inches thick. The following method was adopted for sinking through the sand and gravel. Four wooden girders, each 100 feet long by 6 feet deep, made of pitch pine, were laid over the site of shaft parallel to each other, and about 10 feet apart. These girders rested at each end on 20 baulks lying on the ground at right angles to their direction, with a bearing surface of 720 square feet for each end of the girders, at the greatest possible distance from the centre of the shaft. On these girders were erected a temporary pithead framing, a steam winch, and all the necessary platforms and roads for landing the rubbish raised in sinking. Owing to the large quantity of water, and the fineness of the material sunk through, the whole of the shaft had to be lined with timber framework and piling boards placed close together, and brought down to the bottom as the sinking proceeded, and often in front of the sinking. The curbs were octagonal and built of 12-inch pitch pine baulks spaced 3 feet apart, and the whole were suspended by steel hooked bolts from the girders placed on the surface. The piling boards were 7 inches wide and 2½ inches thick, of the best red pine, an arrangement that proved very successful. When the solid rock was reached, and penetrated to a distance of 6 yards, it was carefully levelled to receive a cast-iron walling curb, upon which walling in brick and cement was built solid to the sides of the excavation, for a height of 4 feet 6 inches. At this level a number of cast-iron blocks having 1½-inch diameter holes through them were laid in the walling, and all the water collected and carried in wooden pipes to the back of the blocks, through which it ran into the shaft and was then pumped to the surface. The blocks were provided with projecting flanges, and very carefully walled in so as to have a watertight setting in the brickwork. From this point the walling was built 3 feet 2 inches thick. Two feet from the face of the walling an annular cavity was left 2 inches wide, which was flushed in with cement and sand as the work proceeded. The whole was carefully backed with solid material, and was built up to within 8 feet of the surface. From this level the timber was removed and a concrete foundation built around the shaft for a depth of 6 feet by 40 feet square, upon which the surface masonry block which supports the pithead framing and landing appliances rests. Two months after, when the mortar had set, the holes in the cast-iron blocks were plugged and the water dammed back. Soon after resuming the sinking, fresh springs of water were struck, and between 90 and 130 yards from the surface the amount made was so great that it was determined to line this portion of the shaft with cast-iron tubbing, as shown in fig. 1, to dam back the feeder of water of 16,000 gallons per hour. A short description of this work may not be without interest. The strata was pennant rock and jointy, in some cases having wide crevices. At 130 yards below the surface there was a bed of considerable thickness, of fairly though not perfectly solid rock, and it was determined to start the tubbing off this bed. The rock was benched around the shaft, and carefully levelled and dressed to a true surface, to widths varying from 3 to 5 feet, as shown in fig. 2, and the sides to a height of 18 inches, and all joints in the rock blocked with yellow pine and wedged as tightly as possible. Two rings of cast-iron wedging curbs, each 8 inches deep and fitting the irregular sides of the pit, were set upon the benching, with oak jointing three-quarters of an inch thick under each ring and between the ends of the segments of the rings. The wedging curbs were blocked with yellow pine, then wedged with wooden wedges until no more could be introduced, and again with finely tapered steel wedges until it was impossible to drive even the sharpened edge of a carpenter's chisel into the blocking. Each curb was blocked and wedged separately. The oak jointing material, which was ¾ of an thick before wedging, was compressed to ⅝ of an inch. The cast-iron tubbing was made in rings 2 feet high, having 12 segments to a ring, with metal 2½ inches thick, flanged all

* From Presidential Address read at a meeting of the South Wales Institute of Mining Engineers.

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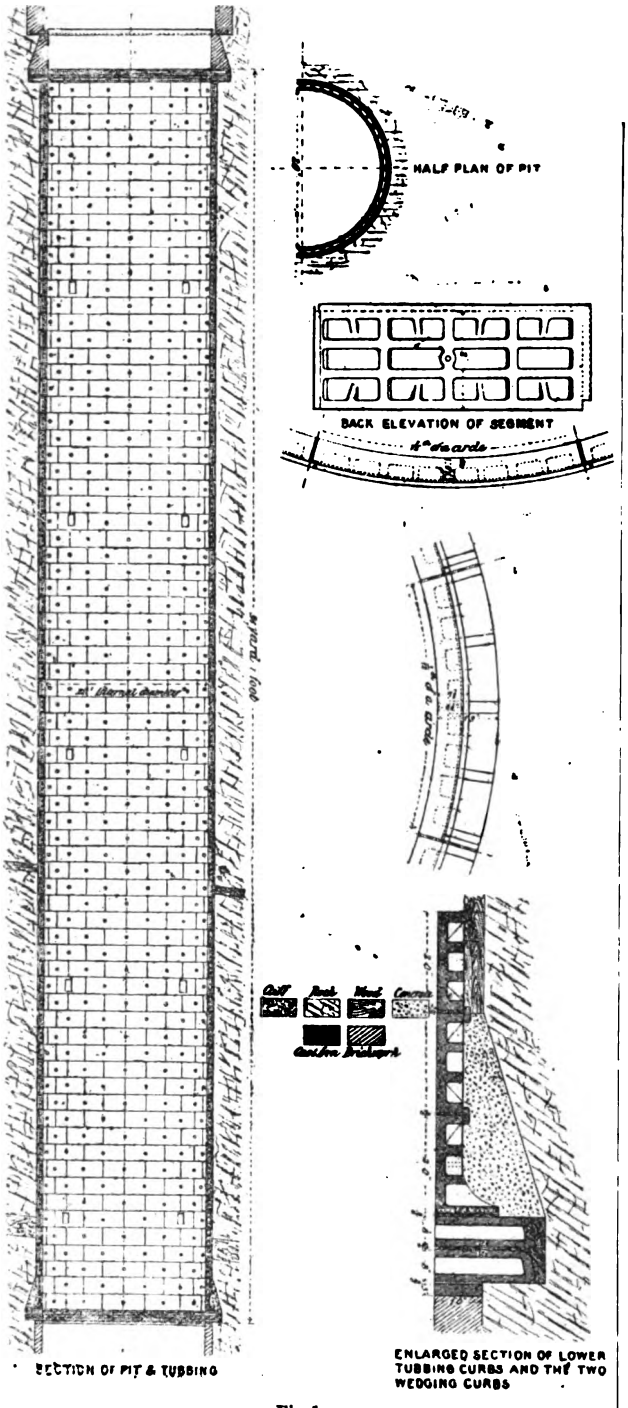
HALF PLAN OF PIT
BACK ELEVATION OF SEGMENT
SECTION OF PIT & TUBBING
ENLARGED SECTION OF LOWER TUBBING CURBS AND THE TWO WEDGING CURBS

Fig. 1.

around 6 inches wide, and strengthened with bracketed ribs across the back. The joints, both vertical and horizontal, were made of yellow pine boards 6 inches wide by ⅞ inch thick. Great care was taken to set the tubbing truly cylindrical, and to maintain it in that form. This was done by carefully wedging between the sides of the shaft and each segment. The space around the four lower rings was filled in with fine cement concrete. The top end of the tubbing was closed in with two wedging curbs in a similar manner to that adopted at the bottom, the total length of the tubbing being 51 yards 1 foot. When completed, the whole of the feeder of water, 16,000 gallons per hour, was tubbed back, and showed a constant pressure on the gauge of upwards of 100 lbs. to the square inch. This proves the possibility of tubbing back water with wedging curbs laid upon pennant rock, a matter upon which there had been some doubt. Fears were entertained—but happily not realised—that the large feeders of water, when tubbed back in the South Pit, would under high pressure run into the North Pit and necessitate the tubbing of that pit also. In the same strata in the North Pit, a feeder of water of 6,000 gallons per hour, having no connection with the large feeders in the South Pit, was successfully walled back by a length of 15 yards of watertight walling of brick and cement 2 feet thick, the ends being closed by means of cast-iron wedging curbs in the

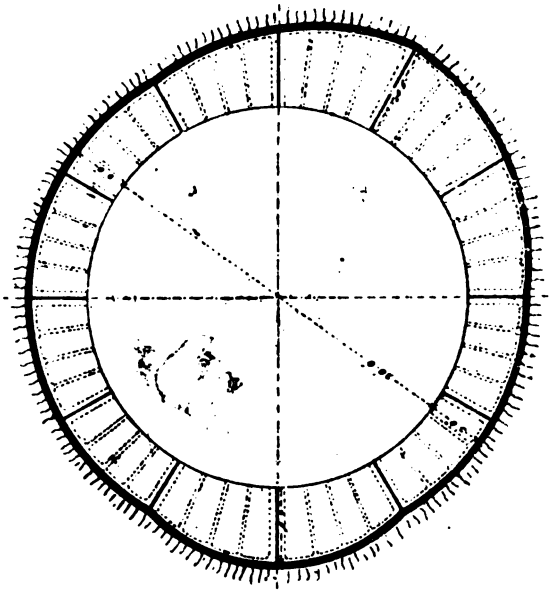

Fig. 2.—Bricking Curb.

same manner as the ends of the cast-iron tubbing in the South Pit, the pressure behind the walling being 60 lbs. to the square inch. Previous to putting in the iron tubbing in the South Pit, and the watertight walling in the North Pit, a heading was driven between the two shafts 155 yards below the surface, and all water above that level was collected in a lodge-room and pumped to the surface in one lift by two direct-acting steam pumps, each capable of pumping 24,000 gallons per hour, the actual quantity pumped being 32,500 gallons per hour. Until the permanent Hathorn-

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Davey pump was erected, the method generally adopted at the Dowlais Cardiff Colliery for dealing with large feeders of water in the bottom of the pits was by pumping by a series of steam pumps fixed one under the other in the sides of the pits. The bottom pumps were well covered to protect them from shot-firing, and closely followed the sinking. They were placed upon beams as near the bottom as practicable, care being taken to ensure their starting quickly and easily after shot-firing. The suction pipes were armoured india-rubber hose, 6 inches diameter, with a fine copper strainer. When shots had to be fired the suction hose was removed and replaced again as soon as possible after firing, and the pumps restarted. This operation took about twenty minutes. When the North Pit reached the depth of 311 yards, a feeder of water of 22,000 gallons per hour was struck, and though attempts were made to continue sinking, the difficulty of dealing with this increased quantity became so great that it was determined to cease sinking operations until the large permanent pumping engine was built and erected, which occupied a period of eighteen months. When this was done, and the set of plunger pumps were fixed at a depth of 155 yards below the surface, the pump rods were carried down the shaft to a point 290 yards below the surface, and connected to the rods of a 16-inch sinking or bucket lift, suspended by ropes in the pit. The sinking lift was fitted with a very thick cast-iron telescope suction pipe, made strong enough to resist the effects of shot-firing. The water raised from the bottom of the pit by the sinking lift was delivered to a direct-acting duplex steam pump having a pair of 24-inch steam cylinders, and four single-acting 10-inch rams, fixed in a lodge-room 220 yards below the surface, which forced the water to the 16-inch plunger pumps at the 155 yards level, and thence by the Hathorn-Davey pump to the surface. Sinking in the North Pit was continued in this way until the large feeder of water was passed, and at a point 335 yards below the surface a heading was driven between the two pits, a lodge-room made, and the second set of plunger pumps, 14 inches diameter, were fixed. Below this point the quantity of water met with in the North Pit was not excessive, and was raised in barrels by winding until the completion of the sinking to a depth of 740 yards. In the South Pit a feeder of water yielding 12,000 gallons per hour was struck at a depth of 405 yards below the surface. This was raised by steam pumps in the way already explained until a heading was driven between the two pits at a depth of 450 yards, where a duplex pump having 16-inch steam cylinders and 8-inch rams was fixed for pumping the water to the 14-inch plunger pumps in the North Pit. Below this point the water was raised by winding. The arches at the bottom of the North Pit will be 23 feet high by 23 feet wide, and those of the South Pit 20 feet by 20 feet; all built of dressed stone, the side walls to be 6 feet thick and the arches 4 feet thick, and in both cases will be inverted with brickwork 3 feet thick.

The British Association.

The annual meeting of this association was held at Liverpool, and commenced on the 16th ult. Numerous papers and questions have been dealt with on scientific and other subjects. We mention a few of them.

Prof. J. J. Thomson, M.A., F.R.S., of Cambridge, President of the Mathematical and Physical Science Section, discussed the nature and properties of the Röntgen or X rays, and of other rays which are produced from a vacuum tube when traversed by an electric current. The report of the committee on the Comparison and Reduction of Magnetic Observations dealing with the differences between the mean values of the magnetic elements at the beginning and end of each day was presented. An appendix to the report by Mr. W. Ellis, F.R.S., discusses the differences between Greenwich and Kew records.

In the Chemistry Section, Prof. Clowes read a paper on "The Limiting Explosive Proportions of Acetylene and the Detection and Measurement of the Gas in the Air." He said the method applied by him to the detection and measurement of firedamp and coal gas in the air served for detecting and measuring acetylene as well. A small hydrogen flame showed a pale but well defined "cap" in air containing any proportion of acetylene less than the lowest explosive proportion.

Prof. Bedson presented the report of the committee appointed to inquire into the constituents of coal. Attempts to extract definite substances from coal by means of solvents have failed, but it has been found that repeated treatment with oxidising agents converts as much as 75 per cent. of the whole into soluble products, the composition of many of which have been ascertained.

Mr. J. E. Marr, M.A., F.R.S., President of the Geological Section, in his address, discussed stratigraphical geology and the effect which the work done on the subject during recent years has had upon our knowledge of geology considered as a whole. Prof. Boyd Dawkin's communicated a paper on "The Geology of the Isle of Man." Mr. G. H. Morton read a paper on "The Range of Species in the Carboniferous Limestone of North Wales."

In the Section on Mechanical Science "The Physical and Engineering Features of the River Mersey and Port of Liverpool" were described by Mr. G. F. Lyster. "The Cause of Fracture of Railway Rails" was the subject of a paper by Mr. W. Beaumont. Captain Jacques, of New York, an acknowledged authority on the subject, communicated a paper on "Armour Plating," in which he states that the United States (The Carnegie Steel Co., Ltd.) and Germany (Krupp) have produced armour at least 15 per cent. better than the best plain steel Harveyed armour that Great Britain has placed upon her battleships. A paper on "Motor Cars" was read by Mr. A. R. Sennett.

PRELIMINARY NOTICE.

Commencing with our next Volume, the first number of which will be published on November 28th, the title of the paper will be altered to "MINING ENGINEERING," extra pages will be added, and the price increased to Twopence.

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Useful Information Relating to Pumps.

By Philip R. Björling.

(Author of "Pumps & Pump Motors," "Practical Handbook on Pump Construction," &c., &c.)

(Specially written for "Mining.")

(Commenced in No. 22, Vol. IV., page 254.)

Lift Pumps.

We will now give a few illustrations and descriptions of some bucket pumps, giving the different arrangements of parts, and, lastly, draw the reader's attention to the most important points in their design, and practical hints on the most approved construction. Fig. 1 (page 254, last issue) is the simplest and most common design of this class of bucket pump employed in collieries and mines. It consists of the working-barrel, A, the bucket, B, suction clack-valve, C, clack-piece, D, fitted with a door for the access to the clack, E is the wind-bore furnished at the bottom with a strainer or snorepiece, F, perforated by holes. The object of the strainer is to prevent chips and other foreign matter from entering the pump and choking the valves. The holes in the strainer are usually 1¼ inch to 1¾ inch in diameter, the collective areas of which should be at least 1½ times the area of the wind-bore. The wind-bore illustrated at E, fig. 1, is called heart-shaped, which is the type usually adopted for sinking purposes, but in such cases the wind-bore is made to slide up and down; this will be illustrated and described later on. The clack-piece, D, is usually bored out to receive the clack-seat; it is fitted with a door, G, for access to the clack and seat. This door is provided with a lug, H, at the top, to which a shackle and chain is secured when the door has to be removed. Sometimes the lug is cast on to the face of the door, as shown at H, fig. 2. The flanges are sometimes faced straight across, but mostly only a narrow facing-ring is formed on the face of the flanges; the facing should be of the same diameter as the distance between the inside of the bolt-holes. The space left by the

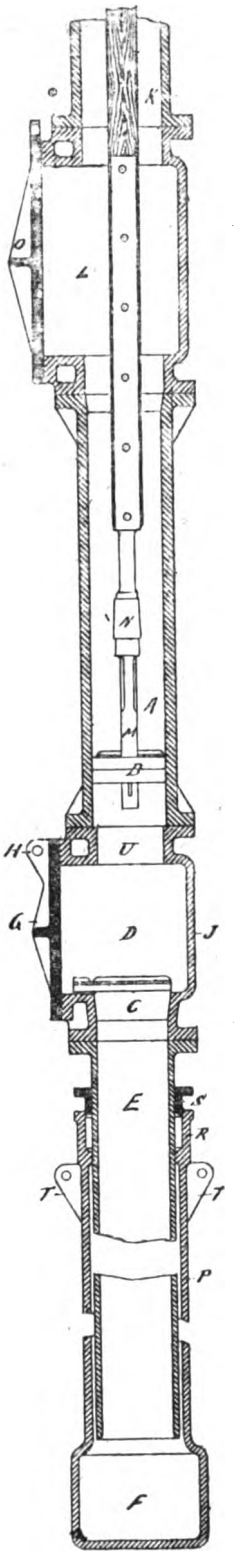

Fig. 2.

facings on the flanges and the joint is useful when the joint has to be broken; steel wedges can be driven in to loosen the joint. The most common and probably the best joint consists of a lead or wrought-iron ring, the former being preferable on account of the iron corroding, wrapped round with flannel or common woollen cloth, soaked in Stockholm tar. When wrought-iron rings are used they ought to be turned ⅛ of an inch thick, and the width of the rings should be such, that when the ring is wrapped with the flannel and dipped in the tar, it will fit comfortably between the bolts when put in, keeping them central with the bore of the pipe. The valve-chamber, J, or swelled part of the clack-piece, should be of ample area, or else the clacks will have to rise too high and long. The area, when perpendicular lift valves are employed, should be equal to the area of the top plate of the valve plus the area of the clear water-way through the valve-seat—that is to say, the annular space round the valve should be equal to the area of the water-way; for clack-valves the radial opening of the clack should not be taken into consideration, but the horizontal projection of valve, as that is the actual surface through which the water has to pass. The projection is an ellipse of the diameter D and $d \cos. a$ (fig 3), therefore:—

$$D = \sqrt{d^2 \cos. a + d^2}$$

but as a rule, in practice, the diameter of the valve-box is calculated in the same manner as for perpendicular lift-valves, although it is best to use the proper rule, as it decreases the clearance space, which is a very important point, because it should always be as small as possible.

The working-barrel, A, fig. 1, should be bored true and parallel, and bell-mouthed at the top, to the same diameter as the pump-trees, K, so as to allow the bucket to enter easily without any danger of damaging the bucket leathers. Some makers cast strengthening bands or hoops round the working-barrel, but that is a plan which is not to be recommended, the casting being apt to be spongy on the inside, opposite the bands, therefore it is better

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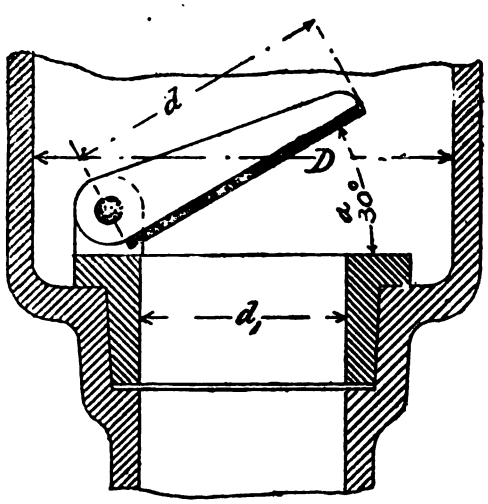

Fig. 3.

to make the metal in the working-barrel thicker, and do away with the bands, although they are very useful when the barrel has to be lowered to rest the chains against, or the clips, by means of which they are held in the shaft. All flanges should be bracketted or ribbed between each bolt-hole, for heavy pressures or where there is any weight to support by them. All holes in the flanges and doors should be cast in, and made at least $\frac{1}{8}$th of an inch longer than the width. Usually, for large pumps the holes are made $\frac{1}{4}$th of an inch wider than the diameter of the bolt. The working-barrels are mostly made of cast-iron; the tendency of them becoming oxidised when iron is used as the material of construction often constitutes a serious difficulty, especially in cases where the water raised is charged with chemicals capable of determining rapid oxidation. In pumps for draining mines the working-barrel and bucket, when made of iron, are frequently destroyed in a short time, and of course in such circumstances a satisfactory degree of efficiency is not to be looked for. To remedy this defect the working-barrel is sometimes lined with brass, and, though the first cost is considerably enhanced thereby, the additional outlay is soon recovered in the higher efficiency of the pump, while the greater durability renders such outlay a real source of economy. It is almost impossible to make the wood spears exactly the required length, especially as the new rods always stretch in the beginning, therefore the working-barrel for bucket lifts and plunger for plunger-sets should be made from 12 inches to 18 inches longer than the stroke; it is also convenient to have a coupling in the spears, by means of which the wood spears can be slightly lengthened or shortened, as the case may require. This coupling consists of two pieces of timber secured by bolts on each side of the top spear-rod, and to the bottom rod by glands, staples, and bolts, the distance between the two rod ends to be made 12 inches to 18 inches, so that when the rods stretch the side pieces can be shifted to suit circumstances.

The pump-trees, K, have for years been made of cast-iron, but the best practice at present is to make them of wrought-iron or steel, which considerably reduces the weight of the pit work and and the ease of handling them in the shaft; it also reduces the number of joints to be made and kept in order, as the wrought-iron or steel pump-trees are made in great lengths, whereas the cast-iron pipes are made in 9 feet and 6 feet lengths and matching-pieces 3 feet and 2 feet long.

The pump spears are made of wood, usually Memel timber, free from defects and knots, and of the greatest length procurable, the lengths varying from 30 to 45 feet, but, whatever the length may be, all the rods should be exactly of the same length, so that a spare rod kept in stock will fit any place in the shaft. The safe load for the wood spears is 5 cwts. per square inch. The different lengths of spear rods are connected by means of wrought-iron plates, technically called "strapping-plates," which should be made thicker in the middle and taper down towards each end, so that the outer ends are about one-half the thickness of the middle, although some, or I might say most, engineers make them parallel for the sake of cheapness, having only to cut the bar-iron, rolled to the required size, in proper lengths, instead of having to forge them taper. Oft times in practice only two plates are used; this is objectionable, for it only ensures rigidity one way. The best method is to have one plate on each side of the rod, although it weakens the wood spears by the cross-holes for the bolts, so that the holes must be taken into consideration when the area of the spears is calculated. The size of the plates must be calculated in the following manner:—Divide the weight to be lifted in tons by the number of plates and by 2, the result being the number of square inches required for each plate; allowance must be made for the area at the bolt-holes. The bolt-holes are usually punched square, the bolts having square heads and necks; the necks are made square so as to fit easy in the square holes in the strapping-plates, to prevent the bolts from turning round when the nuts are tightened up. The methods adopted in joining the wood spears are two-fold, one consists in cutting the timber square across, the second consists of a scarf-joint and a key driven into the middle of the joint. This style is rather costly, as the scarf must be carefully made so as to ensure a perfect fit and to prevent any shake, although it is without a doubt the best method.

It will be noticed in fig. 1, page 254, that if it is desired to remove the bucket all the rods and bucket must be drawn out all the way through the pump-trees. To do away with this tremendous

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labour a bucket door-piece should be introduced between the top of the working-barrel and the bottom flange of the pump-trees; this is illustrated in sectional elevation (fig. 2). The object of this door-piece, L, is to give access to the bucket at the bottom instead of having to draw it and the rods to the top of the pump-trees. To secure this object the doorway is made of such depth that the bucket, B, and prong, M, or bucket-sword, as the case may be, can be removed through it easily by simply knocking it off the knock-off joint, N, which is always provided. The door, O, is in this case furnished with a lug at the top, and the lug, H, for the suction clack-piece door is placed on the face, so that the chains for the latter will clear the nuts and bolt-ends on the bucket door-piece door, O.

The clack-piece, D, is sometimes made with the top branch, U, rather less in diameter than the working-barrel, as shown in fig. 2, the object being that in case the pump-rods should break, the bucket will drop down on the ledge or annular ring formed, hence it is prevented from falling down on the suction clack-valve and injuring it.

Sometimes another clack-piece is introduced between the clack-piece, D, and the working-barrel; this is called the "drop clack-piece," because it is used in case the suction-clack should get out of order, and the water rising fast above the clack-piece door another clack can be dropped down through the pump-trees and working-barrel, instead of fishing up the clack which is out of order or dropping in this clack during the repairs of the ordinary clack, if a spare clack is not kept in stock. The drop clack-piece consists of a plain casting without any door; it is swelled in the middle and provided inside with ribs for guiding the drop clack-shell and clack into its place, which latter is usually bored out to the same taper as the clack-seat, but a little larger in diameter to allow for packing, so as to form a tight joint between them. The packing is sometimes made of leather rings, at other times it consists of tarred twine from $\frac{3}{16}$ to $\frac{1}{4}$ of an inch in diameter, carefully wrapped round the valve-seat. Some engineers and pit-wrights object to the drop-valve, because it is necessary to make it smaller than the diameter of the working-barrel, hence there is always additional friction of the water passing through the seating provided in the drop clack-piece; therefore some prefer to have two suction clack-pieces exactly alike, one placed immediately above the other, so that if one clack hangs or in any way gets disabled or out of order the other will probably be in good working order.

The wind-bore, E, in fig. 1, is of the heart-shaped fixed type, the one in fig. 2 is of the flat-bottomed sliding type. It consists of a fixed pipe, E, on the outside of which another pipe, P, is allowed to slide up and down. The sliding-pipe is at the top and provided with a stuffing-box, R, and gland, S, to form a tight joint between the two pipes. In some cases the fixed pipe is turned all the way, and the bottom of the stuffing-box and the gland bored out to fit the fixed pipe easy, but some engineers prefer to make the stuffing-box and gland castings $\frac{1}{4}$ to $\frac{3}{8}$ of an inch larger in diameter than the rough pipe, so that no turning or boring is necessary. The fixed pipe is always made of cast-iron, but the sliding-pipe is sometimes, as in the case before us, made of cast-iron; at times the gland, stuffing-box, and strainer are made of cast-iron and the pipe of wrought-iron; again at other times we find, for the sake of lightness and consequent ease in handling, the stuffing-box and gland are made of cast-iron, and the pipe and strainer of wrought-iron. The two lugs, TT, cast on the sliding-pipe, are provided for to couple the chains or screwed rod to, for raising or lowering the sliding-pipe. The object of the sliding wind-bore is, that when the pump is used for working under the "sinkers" the men can work under the wind-bore until it has come down the length allowed in the sliding, generally 9 feet, the fixed pipe being 10 feet long, which is as far as the pipe can slide without it coming out of the stuffing-box, 9 feet being the length of pipes mostly used in all classes of pump and pit work; then the joint between the top flange on the fixed pipe and the bottom flange of the suction clack-piece is broken and another length of pipe put in between the flanges. When the suction-pipe becomes too long for the pump to fetch the water, the additional pipes are removed, the pump lowered down to its proper level from the surface of the water, the spears or pump-rods lengthened, and the additional pipes are added to the rising-main or pump-trees until the shaft has attained its desired depth.

There is one objection to the bucket-pump, namely, that the water is throttled on its way through the bucket. This objection can be overcome by making a by-pass and fixing an auxiliary valve on the side of the working-barrel, communicating between the underside and the topside of the bucket; the area of this valve should be equal to the difference between the area of the working-barrel and that of the clear water-way through the bucket-valve. It will be readily understood that as soon as the pressure under the bucket, on account of the friction of the water passing through it, becomes greater than the pressure above it, the auxiliary valve will open and part of the water under the bucket will pass through it, instead of through the bucket, and the pressure will at once be reduced. It is a question whether this arrangement is advantageous or not; it has the great objections of an additional valve to keep in repair, additional joints to keep good, and it takes up more room in the shaft, which in many instances is very objectionable.

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The advantages of the bucket pumps consist in small clearance space between the underside of the bucket-clack and topside of the suction-clack, especially if the suction clack-piece is properly designed; the water rises all the way through the pump, hence no reversal of the current of the liquid takes place and consequently no shocks produced by the flat surface of a piston or plunger meeting the flowing water at the reversal of every stroke. The air which passes into the pump with the water is free to rise straight up as there are no air-lodges. Lastly, it is an easy matter to get at the bucket and the suction-clack through the pump-trees in case the suction clack-piece should be drowned—that is, the water having risen above the door. The disadvantage of bucket pumps is that the leathering of the bucket is soon cut to pieces when the water raised is impregnated with sand and grit.

(To be continued.)

ELECTRIC MINING.*

By Irving Hale, Denver, Colo.

THE superiority of electric power for mining purposes was recognized in a general way as soon as the electric motor became a practical success, but it has required time and experience to amplify and fully develop its advantages and to overcome the minor difficulties that arose.

ADVANTAGES OF ELECTRIC POWER.

These may be considered under three heads, based on the nature of the generating power:

I. *Electricity Generated by Water-Power.*—(*a*) Saving of coal, water for steam (an important item in many places), firemen, handling ashes, boiler repairs. (*b*) Electric motors, as now made, require less attendance and repairs than steam or compressed air engines. (*c*) Underground wires more convenient than pipes. (*d*) Avoidance of losses by steam-condensation underground. (*e*) Avoidance of bad effects of steam underground—heating mine, vitiating air, rotting timbers. (*f*) Electric motors more efficient than the small steam and compressed air engines used on hoists, pumps, diamond drills, etc. (*g*) Rotary motion of electric motor superior to reciprocating motion of engine for many purposes, especially blowers and diamond drills. (*h*) Electric locomotives peculiarly adapted to underground haulage where steam is impracticable.

II. *Electricity Generated by Steam at some distant point were Fuel and Water are cheaper.*—(*a*) Saving of difference in cost of fuel and water between places where power is generated and used. (*b*), (*c*), (*d*), (*e*), (*f*), (*g*), (*h*), same as under I. (*i*) Superior economy of large compound and, where practicable, condensing engines, over the small, inefficient engines used on most mining machinery, proper allowance being made for losses in transforming and transmitting electric power.

III. *Electricity Generated by Steam at place where Power is used.* (*a*) Disappears. (*b*), (*c*), (*d*), (*e*), (*f*), (*g*), (*h*), (*i*), same as under I. and II.

Most of the electric mining plants in this district are included in Class I. Mr. Edward G. Stoiber's Silver Lake Mines plant, described below, will be, when completed, an example of Class II., or rather a combination of I. and II., as a steam plant of the highest possible economy will be used to reinforce the water-power, which is not sufficient throughout the year.

The Metallic Extraction Co.'s pumping plant at Florence, Colorado, is between Classes II. and III. Electricity is generated by steam in the mill and transmitted 1,500 feet (later 4,500 feet) to the pump located near the river, avoiding, on the one hand, the carrying of steam that distance, and, on the other, the keeping of a man at the pumping station.

Class III. is illustrated by the plants of the Pleasant Valley Coal Co. at Castle Gate and Scofield, Utah (hoisting and hauling); the Union Pacific Coal Co., Rock Springs, Wyoming (hauling); and the Colorado Fuel and Iron Co., Rouse, Colorado (pumping, ventilating and miscellaneous power).

COUNTER-CONSIDERATIONS.

Against the advantages enumerated in the preceding section must be charged interest, insurance, taxes and depreciation on the excess of cost of water-power and electric plant over a steam-plant for doing the same work; also the greater cost of attendance, if any, due to the location of machinery at two places, although this will in many cases be more than offset by the saving in attendance on motors, as compared with steam engines and boilers.

CONDITIONS AFFECTING THE COST OF PLANT.

The cost of an electric transmission plant depends chiefly on three conditions:—1st, Nature of water-power (assuming such power to be used) and cost of developing it. 2nd, Distance of transmission. 3rd, Electromotive force or voltage used. In order to show more clearly the effect of distance and voltage on cost of plant, it may not be inappropriate to state briefly the principal electrical laws involved in the problem.

*From paper on Electric Mining in the Rocky Mountain Region. Transactions of the American Institute of Mining Engineers.

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ELECTRICAL LAWS AND FORMULÆ.

(1) Electromotive force, "pressure" or voltage (symbol, E.M.F or E.; unit, the volt) corresponds to pressure of water in pounds per square inch, or head in feet.

(2) Current (symbol, C.; unit, the ampere) corresponds to flow of water in cubic feet per second.

(3) Power (symbol, P.; unit, the watt) corresponds to the power of falling water, and is equal to the product of electro-motive force and current, just as water-power is proportional to the product of pressure or head and flow.

1 Kilowatt=1,000 watts. 1 H.P.=746 watts. 1 Kw = 1⅓ H.P. Formula, P = EC.

(4) Resistance of a conductor to the transmission of electric current (symbol, R.; unit, the ohm) corresponds to the friction of water in a pipe. This resistance is directly proportional to the length of the conductor, and inversely proportional to its area of cross section.

(5) The electric current is equal to the electromotive force divided by the resistance. This is also analogous to the flow of water, which increases with the pressure, and decreases as the resistance or friction increases, although the law is not exactly the same.

Formula (Ohm's law), $C = \frac{E}{R}$

(6) Energy wasted in a conductor by being converted into heat (symbol, H.; unit, the watt, as before) corresponds to the waste of power, also converted into heat, by the friction of water in a pipe, and is equal to the square of the current multiplied by the resistance.

Formula, $H = C^2R$.

CONCLUSIONS.

(A) From (4) and (6) it is evident that increasing the distance, and consequently the length of wire (other things remaining the same), will proportionately increase the resistance and the loss of power; but if the cross section of the wire is increased in same proportion as its length, the resistance and loss will remain the same. This, however, increases the weight of the wire as the square of the distance. Hence the law: *For a given power and electromotive force (which fixes the current) the cost of copper, for a specified percentage of line-loss, varies as the square of the distance.*

(B) From (3) it appears that the same power is obtained from high electromotive force or voltage and small current as from low voltage and proportionally large current—another analogy to water-power. But (6) shows that the loss of power varies as the square of the current, and hence *inversely* as the square of the voltage. If the loss (C^2R) is to remain the same, R can be increased as much as C^2 is decreased, or as much as E^2 is increased, which means that the cross section and weight of the wire will be inversely proportional to E^2. Hence the law: *For a given power and distance the cost of copper, for a specified percentage of line-loss, varies inversely as the square of the voltage.*

(C) Combining (A) and (B) the following law is established: *If the voltage is increased in proportion to the distance, the cost of wire for transmitting a given power with a specified line-loss remains constant.*

(To be continued.)

The Electric Plant at the Abercanaid Colliery, South Wales.*

SOME years since Messrs. J. C. Howell erected an electrical hauling plant at the colliery; and this, with additions which constitute the latest development in the electrical system of power transmission, is capable of dealing with 1,000 tons of coal a day. The machinery consists of a generating plant at the top of the pit, which drives two main and tail rope haulage plants, and three pumps underground, connected by suitable cables carried down the shaft and along the roadway for some 1,200 yards. A small pump on the surface is also driven from the same generating source. The generating plant includes a 40-horse-power compound condensing engine, with cylinders 13 inches and 21 inches diameter, and 24 inches stroke, working at 110 revolutions per minute. This engine drives direct by belt a specially-constructed dynamo of the Crompton type. This machine is of the horizontal pattern, and is built on a wrought-iron girder bed-plate. It is compound-wound, and is capable of giving 180 ampéres at 500 volts pressure when running at 550 revolutions per minute. The conducting cables, of which there are some 3,200 yards, are carried down attached to the side of the shaft, and from the shaft to the haulage engines are run along the roadway. This cable has been specially constructed to resist falls. It can stand a shearing strain of 10 tons per square inch, so that any danger arising from sparking owing to the rupture of the case is entirely avoided. The cable is made up of thirty-seven strands of No. 14 B.W.G. high conductivity copper wire, highly insulated with vulcanised bitumen, double taped, and served with two layers of jute yarn compounded between each, and is protected by a double sheath of No. 8 B.W.G. steel wires, the first stranding being of thirty wires and the second of thirty-six wires, laid up in a direction reverse to the first. The cable is of

* From an article on "The Application of Electricity to Colliery Operations" in the *Electrical Review*.

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ample size to carry the current—180 ampères—the current density being only 337 ampères per square inch, the resistance of the 3,200 yards of cable being ·3192 ohms, so that the loss of potential at full load is 51 volts, or 10 per cent. The operations of starting, stopping and reversing, are carried out with the same facility as similar operations are carried out in machinery worked by steam or compressed air. The motor for No. 1 haulage is a series-wound machine of the Crompton type, built to run at 800 revolutions per minute, and to work with 80 ampères current at 450 volts E.M.F., and at starting, when a higher current is required, it will take 160 ampères without harm. The motor is placed horizontally at one end of a wrought-iron frame, which forms a bed for the drum and spur wheel. The drum shaft, which is of steel, is driven from a counter-shaft by means of spur gearing, and the motor drives the counter-shaft by means of six 1 inch cotton ropes. The haulage engine is fitted with two drums, 3 feet 6 inches diameter and 1 foot wide, fitted with clutches and foot brakes, and was built by the Uskside Engineering Company, of Newport, Mon. This plant will haul coal from three different parts of the pit, and it is expected that eventually coal will have to be dealt with nearly a mile distant. This may be termed a 45 horse-power plant, but there is also a second of similar design but of larger power, viz., 100 horse-power. Both are over-run, the first frequently being called upon to exert 100 horse-power, and the second 150 horse-power and over. The plant runs day and night. The regulation as to speed and reversing of the motors is accomplished by the Howell-Pownall patent switch, on which much time, money, and ingenuity were spent before it was perfected, and the control is such that the armatures of the motors, when revolving at 600 or 800 revolutions a minute, can be controlled to a quarter of a turn, and the manipulation of the switch is as easy, if not more so, than the controlling devices in a steam or compressed air hauling plant.

Answers to Competition Questions.

GIVEN IN No. 20, VOL. IV.

CALCULATION OF VENTILATING MACHINERY.

(1) Describe a ventilating appliance to ventilate a pit (non-fiery) with 500 men and 30 horses; show by figures how you arrive at the result?

Answer.—In the first place we must find out the total quantity of air that is required to circulate through the mine. To arrive at a unit value we must consider (1st) at what velocity it would be economical to cause the air to circulate; (2nd) the height and breadth of the working places. A velocity of 5 feet per second in a 3 feet seam would not be sufficient in a 6 feet seam. In a non-fiery mine we might say 70 cubic feet of air per man per foot of seam, and 120 cubic feet per horse per foot of seam, both per minute, and for the purpose of this question we will assume it a 3 feet seam.

Then $70 \times 3 \times 500 = 105{,}000$
$120 \times 3 \times 30 = 10{,}800$
$115{,}800$ c. ft. per min.

The data required for the calculation of the dimensions of a fan are the volume and the water-gauge, but here we must assume either the W.G. or the probable equivalent orifice, the latter can be got from this formula—

Where A = equivalent orifice in square feet.
" Q = quantity in cubic feet per minute.
" H = height of W.G.

$$A = \frac{\cdot 0003736 \times Q}{\sqrt{H}}$$

I will therefore assume that the equivalent orifice = 30 square feet, which from the desired quantity of say 116,000 cubic feet per minute, means a W.G. of 2 inches approximate.

When A = equivalent orifice and O = orifice of fan, we can find the appropriateness of the fan for the ventilation. The required ratio of A ÷ O being then ·4 (this may be taken as being a fair working ratio), the required orifice of the fan will be—

$$\frac{A}{\cdot 4} = \frac{30}{\cdot 4} = 75 \text{ square feet.}$$

A Guibal fan having an orifice of discharge of 75 square feet would be approximately 30 feet diameter; but we must now find the velocity of the fan to produce the desired volume and W.G. The speed of the rim in feet per second to produce the desired results is determined by the formula—

Let X = speed of rim in feet per second.
" Q = quantity of air in cubic feet per minute.
" A = equivalent orifice of the mine.
" O = orifice of the fan.
" K = a fraction representing the maximum manometric efficiency realised by the fan; this taken as 0·6.

$$\text{Then } X = \frac{Q}{40}\sqrt{\frac{A^2 + O^2}{2K \times O^2 \times A^2}}$$

$$= \frac{116000}{40}\sqrt{\frac{30^2 + 75^2}{2 \times \cdot 6 \times 75^2 \times 30^2}}$$

$$= 2900\sqrt{\frac{900 + 5625}{1\cdot 2 \times 5625 \times 900}}$$

$$= 2900\sqrt{\frac{6525}{6075000}} = \cdot 00107$$

$$= 2900\sqrt{\cdot 00107} = 2900 \times \cdot 033 = 95\cdot 7$$

Therefore the speed of the rim must be 96 feet per second, and the number of revolutions

$$= \frac{96 \times 60}{30 \times 3\cdot 1416} = 61\cdot 1 \text{ revolutions per minute.}$$

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I would have the fan coupled direct with the engine, the speed of the piston would be 61·1 × 2 = 122·2 multiplied by length of stroke in feet, the useful effect in the air being—

$$\frac{116000 \times 2 \times 5{\cdot}2}{33000} = 36{\cdot}56 \text{ H.P.}$$

The power required to circulate the desired volume might be 36·56 × 1·65 = 60·32 = say 65 I.H.P.

SUMMARY.—Fan, Guibal, 30 feet diameter, making 61·1 revolutions per minute, this being of sufficient size and speed to maintain the quantity with a 2-inch W.G. GEO. W. HEDLEY.

LOSS OF PRESSURE IN VENTILATION.

(2) How would you measure the loss of ventilating pressure in turning a sharp corner, say 90°?

Answer.—To measure this loss of pressure I would use two water gauges fitted with verniers, so as to read to the 100th part of an inch. I would fix both side by side in the intake, leaving one end of both open to the pressure of the intake. I would connect pipes to the other ends and carry one, to be open, say a few yards on one side of the turn, and the other a few yards on the other side; thus by reading both carefully and substracting the least from the other gives the height of W.G. in inches, and multiply this by 5·2, gives lbs. per square foot of section lost. JOHN JONES.

THE HUMIDITY OF AIR IN MINES.

(3) A pit, 200 fathoms deep, passes 200,000 cubic feet of air per minute, what amount of moisture will this suck out of the workings of the mine, taking the average temperature and saturation of the air in this country?

Answer.—To find the amount of moisture sucked up out of the workings by an air-current while travelling through the workings of a mine, we must first assume a temperature at which the air enters the mine, also the temperature at which it leaves the mine; next find the volume of air in the different shafts, because the air, before it reaches the upcast shaft, will have increased in volume owing to the increased temperature of the mine. Now, if we assume the temperature of the air in the downcast at 40° Fahr., and that of the upcast 80° Fahr., we might by the use of a dry and wet bulb thermometer, find the humidity of the air on entering and leaving the mine. In the present case by referring to Glaisher's hygrometrical tables we find that a cubic foot of air at a temperature of 40° Fahr. contains 2·9 grains, 1 cubic foot of air at 80° Fahr. contains 11·0 grains, so if we have 200,000 cubic feet per minute passing through the mine in the upcast at a temperature of 80° Fahr., we can find the relative volume in the downcast at a temperature of 40° Fahr., from the fact that 45·9 cubic feet of air expands 1 cubic foot for every degree of heat added; taking it that the quantity of air is measured in the upcast, we have the following:—let K = volume in downcast 459 + 80 : 459 + 40 : : 200,000 : K. K = 185,157 cubic feet. Therefore weight of vapour the air contains when entering the mine = 185,157 × 2·9 ÷ (7000 grs. in lb.) = 76·7 lbs. Weight of vapour the air contains when leaving mine = 200,000 × 11 ÷ 7000 = 314·2 lbs.; hence the difference of weight of vapour in the air on entering and leaving the mine is that which the air absorbs while passing through the workings, which in this case =314·2—76·7=237·5 lbs, or 23¾ gallons of moisture sucked out of the mine per minute.

HUGH B. NISBET.

Correspondence.

MENSURATION.

Sir,—Would Mr. J. N. Wardell or any other reader of *Mining* assist me by working the following question and oblige. Find area in acres, roods, and poles of a coalfield having four sides, each side containing 60 chains, and having a seam of coal 3½ feet thick, with an inclination of 1 in 2. Find the number of tons in the field, taking 32 cubic feet to equal one ton. R.J.

STEAM PRODUCTION.

Sir,—Would you kindly insert the following in answer to "Aspira." The heating value of a fuel depends on the quantity of combustibles, *i.e.*, carbon and hydrogen it contains. Welsh coal contains about 87·8 per cent. of carbon, 5·1 per cent. of hydrogen, ·4 per cent. of oxygen, 1·0 per cent. of sulphur, and 3·7 per cent. of nitrogen and ash. The total heat of combustion of a fuel is the amount of heat generated by the combustion of one pound of the fuel. The total heat of combustion of solid carbon is 14500 thermal units of the Fahr. scale. The total heat of combustion of hydrogen gas is 62000 thermal units. In one pound of fuel, let H denote the weight of hydrogen, O the weight of oxygen, and C the weight of carbon; then since the oxygen in the fuel combines with part of the hydrogen, the net amount of hydrogen available for consumption will be $H - \frac{O}{8}$ lb. The heating value of a fuel is expressed by stating the number of pounds of water that can be converted into steam at 212° Fahr. by 1 lb. of fuel. The latent heat of steam at 212°Fahr. is 966 thermal units, therefore the evaporative power of the fuel will be—

$$\frac{14500\,C + 62000\left(H - \frac{O}{8}\right)}{966} = 15{\cdot}0C + 64{\cdot}2\left(H - \frac{O}{8}\right) \text{ lb.}$$

Thus, taking coal of the composition given above, if all the heat of combustion could be utilised in the boiler, then

$$(15{\cdot}0 \times {\cdot}878) + 64{\cdot}2\left({\cdot}051 - \frac{{\cdot}004}{8}\right) = 16{\cdot}41 \text{ lb.}$$

of water that should be evaporated from and at 212° Fahr. per pound of coal. The evaporative power of the boiler, having a given heating and grate surface, has been investigated by Mr. D. K. Clark (see D. K. Clark's "The Steam Engine"). He made a large number of experiments on different boilers and concludes that the performance of a boiler may be represented by the formula—

$$W = a r^2 + B c$$

Where W = the water evaporated in lbs. per square foot of grate per hour.

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C = the fuel consumed in lbs. per sq. ft. of grate per hour.

R = the ratio of the heating surface to grate area.

A and B = constants, specific for each kind of boiler.

$E = \frac{W}{C}$ = weight of water evaporated per lb. of fuel.

The above may be transformed into the forms—

$$R = \frac{\sqrt{W - B\,C}}{A} \qquad C = \frac{A\,R^2}{E - B} \qquad C = \frac{W - A\,R^2}{B}$$

Each form being suitable for a particular set of given quantities. Average value of the constants A = ·022, B = 29·56 for stationary boilers, and for portable engine boilers, A = ·008, B = 8·60. The following is the performance of a portable engine boiler made by Davey, Paxman & Co.:—

Area of fire grate	3·75 sq. ft.
Heating surface	168·4 sq. ft.
Ratio of heating surface to grate area	45
Coal burnt per square foot of grate per hour	10·3 lbs.
Water evaporated from and at 212° Fahr. per square foot of grate per hour	114 lbs.
Water evaporated per lb. of coal	11·02 lbs.

The following is the results of a Thorneycroft water tube boiler:—

Duration of trial	Two hours
Boiler Pressure (absolute)	194·9 lbs. per sq. in.
Total weight of coal put on fire	3503 lbs.
Total weight of ashes	192 lbs.
Coal burnt per hour	1751 lbs.
Area of fire grate	26·2 sq. ft.
Coal burnt per square foot of fire grate per hour	66·80 lbs.
Total feed water used	31109 lbs.
Feed used per hour	15554 lbs.
Feed temperature	111·2° Fahr.
Steam temperature	379·6° Fahr.
Water evaporated per lb., full	8·89 lbs.
Total heating surface	1837 sq. ft.
Ratio of heating surface to grate	70·1
Water evaporated per square foot of heating surface per hour	8·50 lbs.
Efficiency of Boiler	66·6 per cent.

THOS. WATSON.

What is the value of the economiser or feed water heater? The object of the economiser is to heat the water before admitting it into the boiler. By using a feed water heater, a great saving in fuel is affected, nothing near the amount being needed to heat the water to boiling point, insomuch as it is rendered very hot by the utilisation of the waste heat. Green's economiser is an arrangement of vertical pipes—with horizontal communication above and below—placed in the main flue between the boilers and the chimney. The feed water of the boilers passes in at the bottom of the vertical pipes and out at the top, being heated with the hot gases from the boilers coming in contact with the pipes. To prevent accumulations of coatings of soot, automatic scrapers move slowly up and down the outer surfaces of the vertical pipes.

What is the rate of evaporation and combustion per square foot of heating and grate surface? The heating surface in a Lancashire boiler will not be more than 20 square feet for each square foot of fire grate area, and the combustion of coal may be taken at 15 lbs. per hour per square foot of grate area. Mr. Powis Bale gives the following as a fair average rate of combustion per hour per square foot of fire grate:—

Cornish boilers	12 to 14 lbs.
Lancashire boilers	12 ,, 16 ,,
Portable engine boilers	9 ,, 16 ,,
Locomotive boilers	40 ,, 65 ,,

WM. P. LAWS.

INFORMATION WANTED.

Sir,—Can you kindly refer me to any book which would be useful in designing a large steel pit frame, giving details of the joints, &c. H.P.

(Can any reader supply particulars or acquaint our correspondent with the best source of information on the subject.—ED.)

Competition Questions.

An award of 2s. 6d. will be made to the sender of the best answer to each of the questions given below. Answers to be as brief as possible, and sketches must be made when necessary. One or all of the questions may be answered. Envelopes to be marked "COMPETITION," and to reach us before October 16th, 1896.

We invite readers to forward questions for this competition.

(1) A fan running at a certain speed with its ear closed produced a total W.G. 4 inches. With the ear open to the mine and running at the same speed it passes 20,000 cubic feet per minute, with an efficient W.G. of 3·75 inches. By splitting the air-current in the mine, the fan running at the same speed produces 60,000 cubic feet per minute. What will be the W.G.?

(2) What must be the size of a low pressure cylinder for a high pressure cylinder, 12 inches in diameter by 20 inches stroke. Steam pressure 140 lbs. per square inch, to be cut off at ⅓ths stroke. Equal work to be done in each cylinder. What is the terminal pressure?

(3) If the sides of a circular shaft 200 yards deep suddenly collapsed to such an extent that the whole of the bricking had to be renewed, as portions of the walling was constantly falling out, rendering it impossible to go down the shaft, how would you proceed?

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—G. W. Hedley, Medomsley, R.S.O., Co. Durham.

Commended.—J. G. Bell, Evenwood, Bishop Auckland; T. Graham, Carron Colliery Shieldhill, Falkirk, N.B.; T. Hill, Crosby Villa, by Maryport, Cumberland; J. W. Nelson, Normanby Mines, Normanby, Middlesbro'; R. Forster, 13, Newbottle Row, Houghton-le-Springs, R.S.O., Durham; Wm. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.; W. Stansfield, 8, Quality Terrace, Wardley Colliery, near Newcastle-on-Tyne; W. Mitchell, Dalharco, Patna, Ayrshire; J. Carr, 22, Robert Street, New Silksworth, Co. Durham; J. Jones, Polydfryn, Aberdorfyn, near Ruabon.

Question 2.—J. Jones, Polydfryn, Aberdorfyn, near Ruabon.

Commended.—G. Daykin, 24, High Gurney Villa, near Bishop Auckland; T. Graham, Carron Colliery, Shieldhill, Falkirk, N.B.; W. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.

Question 3.—H. B. Nisbet, Candie, by Avon Bridge.

Commended.—R. Forster, 13, Newbottle Row, Houghton-le-Springs, R.S.O. Durham; J. G. Bell, Evenwood, Bishop Auckland; W. Slocombe, 11, Thorne Avenue, Newbridge, near Newport, Mon.; J. W. Nelson, Normanby Mines, Normanby, Middlesbro'; T. Hill, Crosby Villa, by Maryport, Cumberland; J. Hampson, Holly Bank, Westhoughton; W. G. Jones, Mill Terrace, Mason's Road, Gorseinon, near Swansea; W. Mitchell, Dalharco, Patna, Ayrshire; C. E. Gunn, South Durham Colliery, Eldon, Bishop Auckland; G. Shele, 12, Auckenraith, Blantyre, N.B.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 24. Vol. IV. Oct. 17th, 1896.

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Editorial Notes.

IMPORTANT ALTERATION IN OUR JOURNAL.—As was announced last issue the title of this Journal, commencing with the next volume, which will be issued on Saturday, Nov. 28th, 1896, is to be altered to "Mining Engineering." We have several reasons for enlarging on our present title. Firstly, the word "Mining" is too indefinite; secondly, as we propose enlarging the paper and increasing the price, the alteration in the title will serve to more clearly impress the fact upon our readers and especially upon casual readers. On numerous occasions we have been requested to enlarge the paper and increase the price, and as we found it impossible in our present limited space to cope with the rapid progress in mining we have at last been persuaded to do this. As we only publish fornightly we are not afraid of the increase in price reducing our circulation, inasmuch as we supply such information as can only be obtained from the sixpenny journals, and oftentimes publish exclusive information. Mining Engineers, Colliery Managers, and others can at the very moderate figure of five shillings per year be kept *au fait* with the progress in mining in a manner which will cost thirteen shillings from any other source. "Mining Engineering" will be enclosed in a coloured cover, and its appearance will thereby be greatly improved.

CHESTERFIELD AND MIDLAND COUNTIES INSTITUTION OF ENGINEERS.—A special meeting of the above Institution (Mr. M. H. Mills, President), will be held in University College, Nottingham, to-day, Saturday, October 17th, 1896, at 3 o'clock.

THE EDUCATION OF MINING ENGINEERS.—This was the subject of a presidential address delivered by Mr. G. B. Walker, at a meeting of the "Midland Institute of Mining Engineers," on the 26th ult. He remarked that our students were not less able or industrious than their German rivals, but they were inclined to be too exclusively practical; he urged for greater educational facilities being afforded to colliery managers, and pointed out how unsatisfactory was the training of a mining engineer. He named eight subjects in which a student should have a thorough, not a superficial knowledge, and advocated a period of eight years training as a minimum, viz.:—Two years at a colliery, three years at a technical college, two years at a colliery (underground), and one year at a colliery in the office, after which at the age of 25, and not before, a young man could expect to get his manager's certificate, Of course anyone is prepared to admit that such a training would be superior to the present system of five years, but working on the same basis we might say make the period twelve years, and the training would be still more perfect, in fact it would not only require twelve but fifty years for a man to get a *thorough* knowledge of the eight subjects named. We live in an age of specialists, a man devotes the whole of his life to one subject and finds it quite as much if not more than he can master. We doubt if there is one colliery manager in Great Britain, or for the matter of that in Germany where the training is superior, who can rely implicity upon his own knowledge for all the requirements of the various departments which comprise a modern colliery. There is another point to be considered. What is the inducement offered to parents to give their sons such a costly training, and after the young man has completed such a training, who will guarantee him an appointment of, say £150 a year to commence with?

THE FUTURE DEMAND FOR COLLIERY MANAGERS.—At a meeting of the North of England Branch of the National Association of Colliery Mangers, which was held at Durham, on the 3rd inst., Mr. Wm. Logan, the president, delivered his inaugural address, in which he discussed the coal production of the world and the future demand for colliery managers. Referring to the consumption of coal per head in the United Kingdom and in the United States, he found that whereas it stood at 3·75 tons in 1894 in the former country, in the latter it was only 2·20 tons. This shows that the United States would have to increase its consumption to the extent of 70 per cent. to bring it on a level with that of the United Kingdom. He endeavoured to prove by supplementing his address with statistical tables that the coal production of of the world would go on increasing in the future, and that the number of colliery managers required would not suffer decrease for many years to come.

COAL STATISTICS FOR 1895.—From the mineral statistics just published it appears that the value of the 189,652,562 tons of coal produced at the mines under the C.M.R.A. is estimated at an average of 6s. 0·42d. or 7d. per ton less than that of the previous year. The total output of coal for the year, including the 8,800 tons produced in quarries, was 189,661,362 tons, of which 31,714,906 was exported; 1,166,773 tons, coal equivalent of coke, exported; 617,834 tons, coal contained in patent fuel, exported; 9,407,789 tons, coal shipped for steamers engaged in foreign trade; and 146,754,060 tons remained for home consumption. With the exception of a small quantity from the oolite in Scotland, all the coal was obtained from rocks belonging to the carboniferous epoch, and mainly from the true coal measures.

THE SOUTH STAFFORDSHIRE MINES DRAINAGE COMMISSION.—From the annual meeting of the commissioners which was held at Dudley, on the 7th inst., it appears that the mineral assessed during the year amounted to 3,376,232 tons representing a revenue of £14,067, and that 12,269,840 tons of water had been pumped at a cost of £9,668 19s. 6d. Colonel J. B. Cochrane was re-elected president for the ensuing year.

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Useful Information Relating to Pumps.

By Philip R. Björling.

(Author of "Pumps & Pump Motors," "Practical Handbook on Pump Construction," &c., &c.)

(Specially written for "Mining.")

(Commenced in No. 22, Vol. IV., page 254.)

Force Pumps.

THE class of pump mostly used in collieries and mines is the "plunger pump." This is without a doubt the best class of pump when the water—generally the case in collieries and mines—is impregnated with sand, grit, mud, and other foreign matter, the wear and tear of the plunger being almost nil. The cost of repacking the plunger is only nominal, but the cup-leathers or other leathering for the buckets or pistons are a great expense. The ram being packed from the outside, leaks are immediately detected, and the gland can be tightened in a minute, while the pump is running, and the stuffing-box repacked in a very short time, whereas in a bucket or piston pump a leak can be going on for a long time without being noticed. The ram can be lubricated and the corroding action of acidulated water greatly reduced. The plunger pump like pumps of every other description has its disadvantages. The great body of water between the suction and delivery clacks and in the plunger case causes a less perfect vacuum than the bucket pump, hence the wind-bore must be made shorter to ensure of the pump being filled at every stroke. When the valves are placed at the bottom of the working-barrel there is a large space for air to lodge, and the reversal of the current of water at the end of each stroke is very objectionable, causing shocks by the flat surface at the end of the plunger, therefore, the end of the plunger ought to be rounded or made of an eliptical shape.

One of these pumps is illustrated in sectional elevation, fig. 4; A is the plunger case or working-barrel in which the plunger works without touching the sides, hence it is not necessary to be bored out; V is the gland, and U the stuffing-box in which the plunger works. For large pumps the stuffing-box is made separate from the plunger case, and the flange on the stuffing-box and gland is round; in small pumps they are cast in one and the flanges are square—that is, for plungers up to 7 or 8 inches in diameter. A rim, forming a cup or cistern, should always be provided upon the top of the gland, when the pumps are vertical, for holding water or oil to prevent any air leaking through the gland and stuffing-box, or oil when the water is acidulated. B is the plunger or

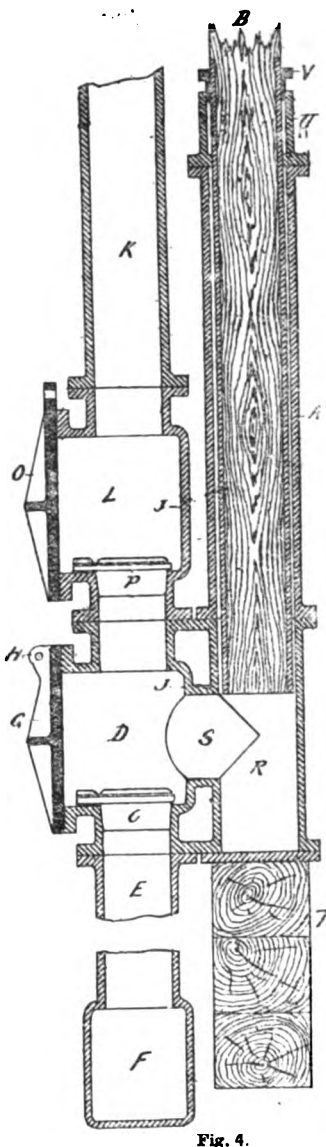

Fig. 4.

plunger-pole, which is turned on the outside so as to work smoothly and water-tight in the stuffing-box and gland. The plunger should never be draw-filed, as is sometimes specified, they should be finished in the lathe with well-defined encircling finish; three days' wear will give a dead polish which will last a long time. For mine pumps the plungers are usually made of cast-iron; in Cornish pit-work they consist of a cast-iron pipe driven tight on to the plunger-pole or bottom end of the spear and secured by soft wood wedges driven in round the bottom of the plunger. If the water to be raised is very much impregnated with acid or other impurities, the large sizes of plungers are made of cast-iron covered with brass, gun-metal, or phosphor-bronze, and the smaller sizes are of the same metals throughout; in the latter case they should be made as thin as possible and well ribbed internally. They should always, in large pumps in the shaft, be made 12 to 18 inches longer than necessary for the length of the stroke of the pump, to allow for inaccuracy of fixing the pumps in the shaft, the length of the spears, which of course, cannot be guaranteed to a few inches, and to allow for the wood spears stretching when they are new. The plungers should be perfectly free from any blow-holes, as they cause the packing to wear quickly, especially if leather packing-rings are used. DR is the H-piece, D being the suction clack-piece and R the bottom of the plunger case, the two being joined together by the water-way, S, forming the H-piece. G is a door for access to the suction-clack; this door should, when clack-valves are used, always be placed in such position that

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he clack opens towards the water-way, S, and the hinge of the clack nearest the door, hence the water is guided into the proper direction. There are two varieties of H-pieces. The one illustrated in fig. 4 has the wind-bore and rising-main in one straight line; this is the arrangement mostly used, because it makes a firm foundation for the pump on the top of the beams, T, and allows any air entering the pump a free passage up the rising-main. But the second arrangement, where the plunger case is in a straight line with the wind-bore, is the best for the current of water flowing into the pump. The pipe, R, on which the plunger case rests, is frequently made as shown in the illustration, fig. 4, but it would have been better if the blank flange had been level with the bottom side of the water-way or throat, S, as it would considerably reduce the clearance space, which is very important; in other cases it is made in the shape of a bend, so as to direct the water into the proper current, which bend is provided with a foot. L is the delivery clack-piece on the top of one of the H-piece flanges; it is in every way similar in construction to the suction clack-piece for bucket pumps already described on page 254, the diameter of the swelled part, J, being calculated in the same way. The wind-bore in this example is of the fixed flat-bottomed type.

In mines and collieries the water is usually raised in stages, that is, a pump, generally of the bucket type, is fixed at the bottom of the shaft, thus delivering the water to a tank or cistern made of wood, iron, or slate; this pump forces the water between 40 to 50 yards into another tank, and so on to the top of the pit shaft. Originally there was a long wood spear from each pump, reaching to the top, where they were joined into one main rod, but now there is only one main rod used, to which all the plunger-poles and the bucket rod are secured by set-offs. The main rod gradually tapers as the amount of work to be done is decreased; if that was not done in some instances the weight would be so great that the spear rod would not be strong enough to carry its own weight. The spears are in some places on the continent built up of wrought-iron or steel plates and L-iron, and in America they are frequently made of hollow tubes of wrought-iron or steel, and in a few instances of solid round forged steel. Sometimes we find two main wood spears passing down the shaft, one on each side of the pump, the plunger-poles and bucket-spears being coupled between the two main spears either by wood set-offs or cast-iron heads provided on the top of cast-iron plungers; this is a very good arrangement, because every part is guided straight instead of being exposed to tilting strain.

When plunger pumps are used the water is forced up by the weight of the moving parts in the shaft and the motor has to lift the dead weight. When the pit is shallow and the weight of the moving parts not sufficient to raise the water, weight must be added. This can be done, if the plungers are large, by placing additional weights inside the plunger, or by cast-iron strapping-plates; these consist of two plates provided with lugs for the bolts, so arranged that the bolts pass outside the wood spears, the rod thus retaining its full strength throughout.

The motive power to these classes of pumping arrangements is connected to the pumps direct from the end of a beam-engine beam; by a direct-acting pumping-engine connected to a T-bob or L-bob at the top of the pit shaft; by a horizontal engine fitted with a pump-crank, the latter being connected by horizontal spears to a T-bob or L-bob; or by a Bull engine placed on the top of the pit shaft, having its piston-rod coupled direct to the main wood spear.

It very frequently occurs that the weight of the moving parts in a shaft is heavier than is necessary to do the work, giving the engine more work to do, consequently a larger engine would be required. To prevent this, balance-bobs or balance-beams are fixed at intervals in the shaft, but only at the top of shallow ones. One end of these bobs is connected with the main spear rod, the other being provided with a box made of wood or cast-iron, containing sufficient weight to balance the unnecessary weight of the moving parts, or part of it, if there is more than one bob in the shaft. These balance-bobs are made of timber with cast-iron ends and centre; altogether of cast-iron, or of wrought-iron with cast-iron ends and centre. Sometimes they are made in the shape of a T-bob with the vertical arm cut short; at other times when only little weight is necessary it consists of an ordinary beam.

T-bobs and L-bobs were originally made of wood with cast-iron heads and centres, smaller sizes being of cast-iron with wrought-iron tie rods; but at the present time they are usually made of wrought-iron with cast-iron centres and head, or channel-iron with cast-iron centres. The length of the arms varies very considerably by different makers, and depends greatly upon bringing in old patterns and drawings; but a good rule is to make the centres one-and-one-half times the length of the stroke of the pumps. The Cornish practice is to allow 20 inches for each foot of length of stroke of the pumps. When the bobs are made of wrought-iron all rivet-holes should be drilled and perfectly fair one with the other; the bolt-holes should also be drilled and the bolts turned to a good driving fit, and a split-pin provided outside each nut, as there is a constant vibration on the bolts and rivets. The tie rods are sometimes made rectangular, at other times round, the former being the best when they are well stayed.

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V-bobs are simply L-bobs in which the arms are at a less angle than 90 degrees.

When horizontal spears are used they must be carried at intervals by rock-arms. These are made similar to the upright arms of T-bobs and L-bobs; sometimes cast-iron, sometimes wood with cast-iron head and centre, and sometimes of wrought-iron.

Fend-off bobs are used for guiding the rods in mine shafts that are not perpendicular the whole of the way, and used instead of V-bobs, because there is less excavation required with a fend-off bob than with a V-bob, which is a great consideration in many cases. These bobs are exactly like the rock-arms and made of similar material.

(*Concluded.*)

The Education of Mining Engineers.

THE above was the subject of a presidential address by Mr. G. B. Walker, delivered at a meeting of the "Midland Institute of Mining Engineers," on the 26th ult., which was held in Sheffield. He said that the coal trade of Great Britain, formerly without a rival, was now hard pressed in the race, and the unquestioned supremacy this country once possessed was hers no longer. Mr. W. N. Atkinson, in his presidential address before the Federated Institution last year, pointed out that the output of coal in the United States would soon have exceeded that of the United Kingdom, and that Germany, France and Belgium in 1884 to 1894 had increased their production of coal by 29 millions of tons, or 31 per cent., whereas the United Kingdom had only increased by 27 millions of tons, or 17 per cent. Mr. Atkinson urged that in view of the changing conditions, the increasing physical difficulties to be surmounted, and the more severe competition to be met with, that it was more than ever requisite that to be successful, the mining engineer should have a very efficient training, both in the practical and scientific knowledge of his profession. He (the president) had held and worked for that opinion for many years past. They were apt in this country to set a less value on scientific attainments in business pursuits than was reasonable, because they rightly attached very great importance to practice and experience. Were it a choice between a scientific and a practical knowledge of mining there could be no question which they must prefer, but under existing circumstances the continued progress and prosperity of the coal trade of this country depended on our raising the standard of scientific attainments to the level of that of our foreign competitors. The problems of surmounting constantly-increasing difficulties, and at the same time reducing the cost of the article produced, and of so producing it as to give it the greatest possible value; the preservation of life and health at greater depths, and under more trying conditions were ever presenting themselves under new and exacting forms; and in the struggle for life those only would eventually survive who could most successfully bring to their aid the resources of science and highly-trained ability. No country had made such strides in the development of her coal resources as Germany. Yet Germany had by no means easy conditions to account for its startling progress. On the contrary, the conditions had been distinctly unfavourable and difficult, and it had only by means of a large measure of engineering skill, and the clever adaptation of means to ends, that the result which had been so striking and so successful had been obtained. The secret of Germany's strong and unceasing commercial advance was the close connection between theory and practice in scientific education. The teaching of science in Germany had as its constant aim the detection of properties of matter which might possess an industrial value; and the detection of these properties was promptly followed by their application. Our students were not less able or industrious than their German rivals, but they were inclined to be too exclusively practical. There was unquestionably more appreciation of the value of good technical training in Germany than at home, and no one could fail to be struck with the enthusiasm with which it was sought for by the miners themselves. In 1894 there were 646 applications for admission to the mining school of Bochum, in Westphalia, notwithstanding that these men would have to attend daily at the school for four hours a day in addition to doing their ordinary work. In our country there was the greatest difficulty in getting students to attend even a single night a week during the winter time. Progress was being made, as the result of the efforts of the County Council, to provide technical instruction in mining as in other trades. From his experience as an examiner he was able to say there was an advance in the knowledge acquired in the various local classes carried on by the West Riding County Council during the winter months, and the lectures given at Sheffield, Leeds and Barnsley were attended by a considerable number of earnest and intelligent young men. But what was two hours a week in comparison with the systematic daily course of instruction provided in Germany, and which was eagerly taken advantage of? After pointing to the great progress made in mining in Germany and the United States, Mr. Walker said the first thing to be done was to look facts straight in the face. Strikes were a serious injury to trade, and the fact that pleasure and amusement had a far stronger hold on the young men of England than among their competitors had to be met. This country was far behind others in the systematic

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courses of technical education essential to the real training of the men who were to take up the battle of this country with its competitors. It was in this direction that their institute, representing the brain of the mining industry of Yorkshire, should make its influence felt, ascertaining what was necessary to make them at least equal to their rivals and then to urge their students forward, and bringing pressure to bear upon the public authorities to get systematic scientific and technical mining instruction extended and improved. Dealing then with the objects to be aimed at in the education of the mining engineer, the present means of instruction in the district, similar institutions abroad, and the extensions and improvements in their own systems of education which they should endeavour to promote, Mr. Walker urged for greater educational facilities being afforded to colliery managers and pointed out how unsatisfactory was the training of the mining engineer, whether he was articled to a mining engineer at a colliery or in the office of a consulting mining engineer. Both these trainings were invaluable in their place, but they were only parts of a thorough course of education. The subjects in which a student should be trained were :—(1) The art and practice of mining; (2) physics (mechanics, pneumatics, hydrostatics, electricity, heat, &c.); (3) chemistry (the elements of inorganic chemistry and the organic hydrocarbons); (4) geology (physiological and lithological); (5) machine construction and drawing, steam and the steam engine; (6) electrical engineering; (7) surveying; (8) mining jurisprudence; and in each of these respects he should have a thorough, not a superficial grounding. Reviewing our present educational facilities, Mr. Walker pointed to the Royal School of Mines—of little value so far as the northern coalfields were concerned. The Yorkshire College, Leeds, and the Firth College, Sheffield, were anxious to promote mining instruction, but the encouragement they had received had not been enough to justify them in providing more than a provisional programme in this particular department. The Durham College of Science, Newcastle-on-Tyne, offered a more complete course, requiring the attendance of a student at least three days a week. He contrasted the work done at these institutions with the courses of instruction given in France, Belgium and Germany, the last of which was most accordant with his own notions. In Germany the system embraced one year given to becoming practically skilled in mining handicrafts, a three years' course of university study, and afterwards three years' technical and scientific training. "How is our mining educational system to be improved?" asked Mr. Walker, and, answering the question, he said the first thing was to persuade parents and the rising generation of students that the present sham technical instruction must give place to some more thorough and far-reaching. No young man could now expect to get his manager's certificate under twenty-five, and he advocated three years at a college and five years at the colliery; or, better still, two years at a colliery, three years at a technical college, two years at a colliery (underground) and one year at a colliery (in the office). A youth who went through such a course would be turned out a thoroughly competent man, capable of eventually filling the highest posts. It would be a course quite equal to those of France and Germany. A recognition of college training in settling the qualifications for candidates for colliery managers' certificates should be obtained from Government, the Yorkshire and Firth colleges should be asked to arrange courses at least as complete as the Durham College of Science, the county councils should be enlisted to help, and in the matter of funds the colliery proprietors would no doubt give a helping hand. A more complete scientific education had become essential for mining students; the only thing wanting was an appreciation of the true state of affairs and the determination to put themselves on a sound footing. No more important work could be done by the institute, and he commended it to their serious attention.

Coal Mining in India.*

The Mohpani Mines.

THESE mines are owned by the Nerbudda Coal and Iron Company, Limited. The system carried out in working this mine is a pretty close copy of north of England practice.

Inspections.—An inspection of all working places and travelling roads, and any other parts likely to affect the safety of the mine, is made several times during the shifts, and once immediately before the commencement of the shift when there has been a break of work; but ordinarily the mine is worked continuously throughout every twenty-four hours by three shifts of eight hours each. These inspections are ordinarily made, first by the mates, then the overmen in the fore shifts, and the deputy overmen in the other shifts, and general inspections by the underviewers and manager. The waste parts outside the regular workings are also inspected weekly by the overmen. The mates, overmen, and the deputy-overmen eaoh write a daily report at the end of their shift of work; the reports are made in books provided for the purpose, and are daily initialled by the underviewer. The underviewer also sends a daily report to the manager. Weekly reports of the inspections of the mine wastes are also made by the overmen. The machinery, ropes, chains, and boilers are inspected and reported on daily by the engineer or his foreman; this is made in a book kept for the the purpose in the engineer's time office, and the weekly reports of the weekly examinations of the

* From Mr. Grundy's H.M.I.M. Report.

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shafts are also recorded in the same book. All the reports are written in English, and a Munshi writes them for the native examiners.

System of Working.—The seams of coal are known by the numbers 1, 2, 3, and 4; and vary in thickness from 3 to 25 feet. The system of working out the coal is, taken altogether, quite unique for India. The mine was first cut out on the bord and pillar, or pillar and stall system and all the pillars are now being bodily worked out by a species of longwall working, that is, much after the same form as longwall working: and nearly the whole of the waste or goaf immediately behind the working faces is filled with "mati," stones and rubble, quarried on the surface and sent into the mine for packing. In addition to the packing being kept filled in and built up to within a few feet of the working faces, each working face is thickly timbered between the coal and the pack walls, and in the bords adjacent to the faces, but nearly all the timber is withdrawn as it is being replaced by packing. As a rule the roof breaks off the face and settles on the packing. In all cases where possible the ingoing dirt for packing is made to haul out the coal. The way that portions of the coal seam are worked away at one time is called working by lifts, and the workings are now all in "brokens" which are being worked back from the boundary by a system of horizontal lifts in ascending order, each lift being 6 to 8 feet in thickness; all the lifts and galleries are packed solid with earth and stones sent from surface, excepting the top slice, in which about one-third the area of that thickness is left unpacked. This part that is left open and unpacked is arranged so as to be between built-up pack walls.

Ventilation.—In the principal part of the workings ventilation is produced by a Capell fan 7 feet diameter and 6 feet wide, double entry, and worked by a single engine and leather belt at about 100 revolutions per minute, the engine running at 20 to 25 revolutions per minute. In another district the workings have natural ventilation in cold weather, and in hot weather a furnace 6 by 5 feet area, is kept continually going when required. Double-winged wooden air doors are also used, also brattice doors, and cloth and brick bratticing, and cloth and brick-fast air stoppings.

Blasting.—An effort is made at this colliery to carry out the safety principles of the English mines Acts as to carrying the explosives into the mine in tin cases or canisters, and in cartridges; amout taken at one time; inspecting before and after firing; charging, stemming, stemming material and tamping rods; and in treating miss-fired charges, and places of miss-fire.

Timbering.—Mine carpenters fix all timbers to secure the roof and sides of the mine workings; they are directed, principally, by the native mates and the overmen; and they timber any place which they think requires it without instructions. The hewers do not secure their own working places, and seldom assist or give a helping hand, not even to the setting of sprags to the coal in their own working places, where required.

Wages.—The approximate wages earned by the employés are:—Below ground—hewers, about 6 annas per day; mates, about 7 annas per day; datallers (labourers), 3 to 4 annas per day; door boys and carriers, 2 to 2½ annas per day; other carriers, 3 annas per day; carriers working on fixed wages, 2 annas per day. Above ground—men, 3 annas to 1-4 rupees per day; boiler and shop boys and carriers, 2 annas per day. Female carriers and others doing general labouring work, from 1½ to 2 annas per day when on fixed wages, and 2 to 3 annas per day when working on contract.

North Staffordshire Institute of Mining and Mechanical Engineers.

A SPECIAL MEETING of the members of this institute was held at Stoke-upon-Trent, on Monday, the 28th ult., when Mr. E. B. Wain, the president occupied the chair. Mr. Joel Settle was nominated for the presidency, and will be elected at the annual meeting.

The Coal Mines Regulation Act.

The president directed attention to the Act passed in August last to amend the Coal Mines Regulation Act of 1887. He observed that the new Act provided that the Home Secretary might make special rules as to the description of explosives which might be used. It gave the Home Secretary power to make special rules as to the watering or efficient damping of the mine, or any ways or places therein. He (the president) took it that these special rules would be made in accordance with the principal Act, and in case of dispute the matter might be referred to arbitration. Another important arrangement was that where working men in such arbitration were given power to nominate some person to appear for them, they would be charged a portion of the costs of the arbitration. There were also provisions as to more accurate plans of the workings and also of abandoned workings. Perhaps the most important consideration was in the 6th clause, by which the Secretary of State was given power, on being satisfied that an explosive was, or was likely to be dangerous, to prohibit its use. In that case he took it that the Home Secretary had absolute power without any arbitration or reference whatever. The Act, he believed, was already in operation.

Mr. W. N. Atkinson, H.M. inspector of mines, remarked that the Act came into force as soon as it was passed, August 14th, and there were certain sections requiring immediate attention of the colliery owners and managers. Section 3 referred to the plan and manner of working. The plan kept in pursuance of section 34 of the principal

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Act must show the position of the working therein with regard to the surface and the position and direction of every known fault or dislocation of the seam, with its vertical throw. On the majority of the plans the surface works were shown; the faults were shown on all plans, although not some of the small faults, nor the vertical throw. That was a point requiring attention at once.

The President asked whether that meant that all buildings, fences and surface works must be shown on the working plans?

Mr. Atkinson replied that he was not in a position to give a legal opinion on that point, but he should say not. It did not refer to every surface mark, but only sufficient to show the position of the workings with regard to the surface. Then section 4, referring to the abandonment of a mine, was of immediate application, requiring an accurate plan of the mine or seam—either the original working plan or an accurate copy by a competent draughtsman—to be sent to the Home Secretary within three months of the abandonment. Then Clause 5 referred to the lamps, inspection, and tamping. The inspection before the commencement of work extended to all working-places in which work was temporarily stopped. It meant that the working-places which were temporarily off work would have to be reported upon as well as those in actual operation.

Mr. J. Richard Haines (secretary) said that it meant that every district of a mine must be clear whether it was at work or not.

Mr. H. M. Makepeace mentioned that the original Act said "each working-place." In well-managed collieries such places were examined, but cases had occurred where they had not been examined because they had been fenced off and not intended to be worked. He thought this section forced the inspection of each place though it might be fenced off.

Reference was next made to the clay used for tamping, which formed the subject of one clause, and Mr. Makepeace said if there was in the mine nothing but bituminous shaley clay for tamping, proper clay for tamping must be taken down the pit. It was mentioned by the Secretary that it was an advantage to use proper clay, because by doing so they got better results. Reference was further directed to section 4, requiring the accuracy of plans to be certified, so far as was reasonably practicable, by a surveyor or other person approved in that behalf by an inspector of mines.

North of England Institute of Mining and Mechanical Engineers.

A GENERAL MEETING of the members of this Institute was held in the Wood Memorial Hall, Newcastle-on-Tyne, on Saturday, October 10th, 1896. Mr. George May, the newly elected President, occupied the chair. After the election of new members and the transaction of other routine business, a paper by Bergassessor Winkhaus on the danger of employing

Safety Fuzes

for blasting in fiery mines was read. The writer said that for the past eighteen months, so-called "safety fuzes" and "safety igniters" have been employed in the mining district of Westphalia, in order to ensure greater security in blasting in fiery and dusty mines. The igniters that have been chiefly used are those of Norres and Roth; the principle of both of these consists in lighting the fuze inside a metallic cap, which is nipped on to the end of the fuze, and which is supposed to stifle the jet of flame thrown out when the fuze is lit. The employment of these methods of ignition has, however, been found dangerous in several respects. A series of investigations was iniated by the workmen of the Consolidation pits, near Schalke, and continued in the experimental drift of the Westphalian Miners' Association, particulars of which are given in the paper, and the conclusion is arrived at that the use of fuzes with very resistant coverings which are not destroyed by the burning of the core, must be looked upon as a source of danger; and, in the writer's opinion, there is such danger in the use of all fuzes in which explosive phenomena can be produced by compression, as above described. Only those fuzes should be considered secure against sudden firing which are partly destroyed when the core is burnt, because with these a great part of the space occupied by the fuze is free for the escape of gas, so that compression can entail no risk. The writer considers that in fiery mines the degree of safety attained in lighting safety fuzes must, in the main, depend upon the skill and trustworthiness of the miner employed. In conclusion the paper recommends the adoption of electrical shot firing. The fear that even electrical ignition may not be quite free from danger in fiery mines (because if the connection with the main cable be badly made, sparks may strike across outside the shot-hole), is not, in the writer's opinion justified. This danger can be completely avoided by making the insulated wires of the detonator, and the corresponding insulated wires of the conducting cable of different lengths; the non-insulated ends of the wires would then be so far apart that it would be impossible to bring them dangerously close together. In addition to its almost absolute safety from fire damp explosions, electric ignition has the further great advantage, that accidents due to shots being fired too soon or to late are completely prevented. A discussion of the paper followed, and was afterwards adjourned.

The Venterskroom Goldfields.

Mr. H. B. Bunkell submitted some notes on the Venterskroom Goldfields, South African Republic, being the results of an inspection of properties near Venterskroom on the Vaal river. In the discussion which followed the reading of the paper Prof. Louis and others deprecated important conclusions being arrived at on such slight evidence as often appeared in papers read on the geology of South Africa.

A Spring-Coupling for Winding or Hauling Ropes.

Mr. H. W. Hollis described a spring-coupling designed to minimise the starting strain on hauling and winding ropes. The coupling or attachment consists of a pivoted frame composed of two end plates, one or both of which may be formed or provided with a hook. The end plates are connected to the side plates by means of links, which are pivoted to both of these plates. The side plates are normally held apart by means of a spring, through the centre of which passes loosely a rod, one end of which is secured to the side plate, while the other end passes loosely through the opposite side plate. The appliance had been adopted with conspicious success at West Thornley Colliery. At the conclusion of the General Meeting, a Meeting of Students was held, Mr. G. P. Chaplin presiding, when a paper previously read by Messrs. W. R. Bell and E. McGowan on the haulage arrangements at Wearmouth Colliery was discussed.

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ELECTRIC MINING.*

By Irving Hale, Denver, Colo.

Continued from last Issue.

THE following table shows the cost of copper, at 14 cents per pound, per kilowatt transmitted by the two-wire system for various distances at different voltages, with 10 per cent. waste of energy in line:—

Volts.	Miles.							
	1.	2.	3.	4.	5.	10.	15.	20.
	dols.	dols.	dols.	dols.	dols.	dols.	dols.	dols.
500..	20.00	80.00	180.00	320.00	500.00	2,000·00	4,500.00	8,000.00
1,000..	5.00	20.00	45.00	80.00	125.00	500.00	1,125.00	2,000.00
2,000..	1.25	5.00	11.25	20.00	31.25	125.00	281.25	500.00
3.000..	.56	2.22	5.00	8.89	13.89	55.56	125.00	222.22
4,000..	.31	1.25	2.81	5.00	7.88	31.25	70.31	125.00
5.000..	.20	·80	1.80	3.20	5.00	20.00	45.00	80.00
10 000..	.05	.20	.45	.80	1.25	5 00	11.25	20.00
15.000..	.02	.09	.20	.35	.56	2.22	5 00	8.89
20,000..	.01	.05	.11	.20	.31	1.25	2.81	5.00

Considering the fact that the total cost of steam or water-power, electric generators, switch-board and motors seldom exceeds 150 dollars per kilowatt, it is evident that when a distance is reached that makes the cost of wire (and transformers, if used) exceed that amount, or the entire cost of the remainder of the plant, that distance may be considered to be near, if not beyond, the economical limit, unless the conditions are peculiarly favorable for electric power.

With 500 volts this condition is reached inside of three miles; with 1,000 volts, inside of six miles; with 3,000 volts, at about seventeen miles, and with 10,000 volts, at about fifty miles (allowing for transformers).

It is evident from the foregoing principles and figures that the key to long-distance transmission is high voltage.

Systems.

Direct Current.—Direct-current generators, suitable for power-purposes, cannot be made to operate successfully at a much higher electromotive force than 1,000 volts, on account of the arcing and short-circuiting of the commutator and its connections required to rectify the current.

The direct current cannot be transformed to a higher voltage, except in a machine similar in construction to a generator and open to the same objections.

The expedient of connecting several generators in series, thus multiplying the voltage, has been tried in a few cases, but it is suitable only where power is to be transmitted and used in large units. It would be manifestly impracticable to connect several motors in series for small powers, and especially for such purposes as running hoists, pumps, blowers, and other mining-machinery.

Single-Phase Alternating Current.—The single-phase alternating-current generator can be wound without difficulty for 3,000 to 4,000 volts, and considerably higher if necessary, as the current is taken off from two continuous rings without rectifying it, thus avoiding the difficulties experienced with the commutators of the direct-current machine.

By the principle of induction, an alternating current of moderate voltage can be transformed into a current of smaller amperage and proportionally higher voltage, for transmission, and can be re-transformed at the other end of the line to any voltage desired for lights or power, the amperage varying inversely as the voltage. The energy remains the same, excepting a small loss in the transformation, not exceeding 2 per cent. in large transformers. As the coils of the transformer are stationary, and there are no sliding-contacts, any desired amount of insulation can be used, and almost any voltage can be generated that can be controlled on the line. Many plants are in operation at 10,000 to 12,000 volts, and as high as 50,000 volts has been used experimentally with promising results.

The single-phase alternating current is widely used for lighting, but, being a simple alternating wave, is not suitable for power, as no satisfactory single-phase alternating motor of large size has yet been devised that is self-starting under load and capable of speed regulation. If a motor built on the same lines as a single-phase generator is brought up to the proper speed by some extraneous power, so that the alternating impulses will act in the right direction at the right instants, and the current is then sent through the motor and the load gradually thrown on, it will run satisfactorily at constant speed. Such a machine is called a synchronous motor, because it runs synchronously, or in step with the alterations of the current. Its speed cannot be regulated; and if a sudden load causes it to slow down and lose step, it stops. It is inconvenient, and in fact impracticable, for service were frequent stops and starts are necessary, because starting it is such a tedious operation, and if it must start with load on, it cannot be used at all.

Multiphase Alternating Current.—The successful development of the multiphase system during the past four years has solved the problem, and secured the advantages of both the direct and alternating currents. A multiphase generator has several windings, so placed as to generate several alternating currents differing in phase, that is, passing the zero and maximum points at different instants. Under the influence of these currents (which may be compared roughly to the cranks of a duplex or triplex engine—no dead-centre), multiphase synchronous motors are self-starting under light load, while non-synchronous or induction motors will start under full load, and are capable of speed regulation. The latter possess the good qualities of direct current motors, and the additional advantage of having no commutator

*From paper on Electric Mining in the Rocky Mountain Region. Transactions of the American Institute of Mining Engineers.

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and, unless speed regulation is required, neither collecting rings nor brushes, the wires being simply connected to terminals on the field of the machine. On the other hand, the multiphase alternating current, like the single phase, retains the indispensable quality, for long distance transmission of being transformable from low to high voltage for transmission, and from high to low for use at its destination.

Electric Mining Machinery.

Electricity is being applied to the operation of every kind of machinery used in mines.

Hoists.—The first application of electric power, and one of the simplest, was to hoisting; the rotary motion of the electric motor being easily adapted to this work.

Most of the earlier machines consisted of street-car motors, geared to flat-friction or V-friction hoists. This type is very satisfactory for small or medium-sized machines, as the friction gear is an assistance to the motor controller in smooth starting.

For large hoists a positive geared motor is more reliable; but it is desirable to interpose a friction clutch or equivalent device at some point between armature and drum, as a safeguard in case of excessive strain on gearing, caused by the inertia of the armature when the drum is stopped by a too sudden application of the brakes. Mr. D. W. Brunton, of Aspen, has designed a slipping pinion, which is used on the electric hoists in mines under his management, and serves this purpose admirably.

The choice of the best kind of motor depends considerably on the size of the hoist, its location, and the nature of the work. For an unbalanced hoist of moderate size, especially if placed underground and exposed to dirt and water, the ironclad series-wound street-car type is well adapted, as it is strong, well protected and designed to stand heavy work on intermittent service. In this motor, efficiency, low heating and absolute freedom from sparking are to some extent sacrificed for compactness and lightness. For large hoists, which are generally located in comparatively clean, dry places, and, if over-balanced, work almost continuously, hoisting and lowering, and in which high efficiency is more important than in small hoists, the stationary type of motor is usually preferable.

The speed-controller is one of the most important features of an electric hoist. On many of the earlier hoists the commutated field, thrown into various combinations of different resistances by a cylinder switch, was employed; this form of control being at that time widely used in street-car service. This controller gave quite satisfactory results when assisted by friction gearing; but with positive gearing it would not give a sufficiently gradual start. On most hoists a variable resistance in armature-circuit is employed; and by making this resistance sufficiently high, a perfectly smooth start may be obtained, even with slack rope. The most satisfactory rheostatic controller, especially for heavy work, is one in which the resistance is cut in and out by a cylindrical switch with magnetic blow-out, which avoids the troublesome effect of arcing at contacts, when the current is broken.

In some cases it is practicable to use a double-motor equipment, with series parallel controller, such as is now employed almost exclusively in street-car work.

By overbalancing a hoist, making the counter-weight equal to the dead load plus about half the live load, the work in hoisting and lowering can be made approximately equal, and the maximum current and size of motor can be reduced to considerably less than half of what would be required for doing the same work with an unbalanced hoist. This principle is used in the electric hoists at the Free Silver, Alta Argent and Della S. mines at Aspen, and the Silver Lake mines at Silverton, and will doubtless be employed more generally in the future than in the past.

The Alta Argent hoist, in addition to being overbalanced, is arranged in a novel manner. The hoist, with its motor, is placed on a substantial platform above the head of the incline, and is out of the way of the operator, who is located, with the controlling levers, just below the hoist and on the level where the cars are run off. This gives more room for handling the cars as they are raised, and enables the hoist operator to do this work.

The largest electric hoist in the world is on the Free Silver shaft at Aspen, Colorado. It is an overbalanced double-reel, flat-rope hoist, equipped with a 100-Kw. 4-pole motor, capable of developing 120 H.P. continuously and 150 to 175 H.P. intermittently. An auxiliary 60 H.P. motor, ordinarily doing other work, is arranged so that it can be geared to the hoist counter-shaft and assist the large motor if necessary. Each reel has 1,500 feet of 4 by $\frac{3}{8}$-inch flat rope, weighing $2\frac{3}{4}$ pounds per foot. The cage weighs 1,375 pounds, bucket and ore (hung from cage in sinking) about 2,400 pounds, car and ore about 3,500 pounds, and bailer, containing 111 cubic feet of water, about 9,000 pounds. Two counter-weights are used, the one for cage and bucket weighing 2,450 pounds, and the one for cage and car 2,675 pounds, the two being combined when bailing. Two armature pinions are provided (the motor sliding on rails), one for ordinary hoisting giving a speed of 600 feet per minute, and the other for bailing at 1,000 feet per minute, which, with the maximum load of about 10,000 pounds (bailing), would require over 300 H.P. net, exclusive of friction in gearing and rope, were it not for the overbalanced arrangement. Actual tests have shown that the average current consumed in hoisting with counter-weight is only about one-third of the amount required when the hoist is unbalanced.

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Pumps.—The electric pump presents a somewhat more difficult mechanical problem than the hoist, on account of the conversion of rotary into reciprocating motion, and the importance, in most cases, of compactness and protection of the motor against water. That the problem has been satisfactorily solved, however, is proved by the large number of electric pumps of various kinds and sizes in successful operation.

Duplex and triplex pumps, both vertical and horizontal, are suitable for operation by electric motors. For small pumps, where plenty of space is available, a belted motor affords the cheapest arrangement and gives satisfactory results. In the majority of cases a geared pump with motor on the same base is best. Both spur and worm gears have been used successfully, various devices being employed with the latter to neutralize the thrust. In the Virginius 70 H.P. pump, the armature shaft carries two worms, one right and one left-hand, working into two gears which mesh into each other. In the 15 H.P. pump in the same mine, the armature is placed vertically, and its weight approximately offsets the thrust. In most of the electric pumps made during the past few years, spur-gearing has been used, and with good results.

Blowers.—The running of blowers and exhausters is another simple operation, the motor being either belted, geared or direct connected to the blower shaft. Small outfits of this kind, placed at various points throughout the mine, run continuously with very little attention, and afford the most economical and satisfactory ventilation—far superior to the vitiated air that has passed through air compressors and drills.

Percussion Drills.—To obtain with electricity the rapid reciprocating motion with varying stroke and necessary elasticity required in a percussion drill, and at the same time get a machine that will stand unlimited abuse, has been the hardest problem in the mining field that the electrician has had to solve.

Two general methods have been followed. One employs the ordinary rotary motor, connected to the drill by a flexible shaft and producing the oscillatory motion by cranks, cams, levers, springs, and similar devices. The other uses the solenoid principle, the plunger being moved back and forth within two solenoids, placed end to end, by currents sent through the two alternately, these currents being shifted automatically at the drill or generator—generally and preferably at the latter.

The solenoid type of drill is the only one that has been used commercially and successfully in this country. These drills were tried in several mines in Colorado and elsewhere about four years ago, but were only partially satisfactory. The principal defects were lack of pulling power, heating of solenoids, unsoldering of connections and breaking of drill chucks, due to the crystallization of the bronze of which they were at that time made. These defects have been remedied by better electrical and mechanical design of solenoids and connections, and the adoption of an all steel plunger and chuck. The improved drills have been used successfully for some time in quarrying and tunneling in the East.

Diamond Prospecting Drills.—In contrast with the percussion drill, the rotary diamond drill is more easily and satisfactorily operated by an electric motor than by any other power, not only because the rotary motion of the motor can be applied directly to the drill, while the reciprocating motion of a steam or air engine must be converted, but also because the former is much steadier than the latter, and causes less wear and breakage of carbons. Moreover, the transmission of power into a mine by electricity is more economical than by steam or air, and the electric drill, with its wires, can be more conveniently moved from place to place than the steam or air drill and pipes. On account of these advantages the electric diamond drill has become a favourite wherever current can be conveniently obtained.

Coal Cutters.—Electricity was successfully used for coal cutting even when the direct current motor was the only kind available. The application to the chain cutter of the three-phase induction motor, without commutator, collector or brushes, and avoiding all possibility of sparking, has produced an almost ideal machine for this work. Another valuable characteristic of the induction motor for this kind of service is the fact that, when overloaded beyond a certain limit by striking a hard stratum or by sticking of the cutter, it stops, thus relieving both motor and machine from excessive strains. These coal cutters are being rapidly introduced in the East, but have not yet been used in this part of this country.

Locomotives.—Electric haulage in mines, under ordinary conditions and where distance and tonnage are not too small, is without much question superior to any other system available. It is more flexible than rope haulage and more economical than mules or compressed air.

Electric locomotives have been principally employed in coal mines on account of larger tonnage and longer hauls.

Mine haulage is similar in most respects to street railway service; but the locomotives must generally be adapted to narrower gauge, the motors should be better protected, the speed is slower and the weight on driving wheels greater.

The series parallel controller, now so widely used in street car services, which throws the motors in series for starting and slow speeds, and in parallel for higher speeds, is not so suitable for a mining locomotive, for the reason that the slipping of one pair of wheels (which is more liable to occur than on a street car, the load being behind the locomotive and the rails being more slippery) increases the speed of the motor on that axle, raises the counter-

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electromotive force and cuts down the current through both motors, if in series, thus reducing the power of both. For this reason some form of rheostat-controller is generally used.

The essential requirements in a mining locomotive are compactness, strength, simplicity, convenience of handling and especially durability and freedom from repairs.

FUTURE DEVELOPMENT.

During the past eight years, and principally in the last four years, 52 distinct companies in the Rocky Mountain district alone have installed electric-power machinery for mining and ore reducing purposes, comprising 62 generators, aggregating 7,988 kilowatts, and 135 motors, aggregating 4,816 horse-power, operating every variety of mining and milling machinery.

Electric apparatus, formerly regarded as delicate and peculiarly subject to break-downs, has been brought to such a degree of perfection that depreciation and repairs may be considered as less on this than on almost any other kind of machinery.

The multiphase high voltage system has brought nearly every mining district within economical reach of water-power.

The induction motor, without commutator, collector or brushes, is the acme of simplicity and durability.

Electro-metallurgical operations are increasing and give promise of success.

Under these conditions it may be safely predicted that during the next five years much greater progress will be made, and the application of electricity will become one of the most attractive and important features of mining economy.

(*Concluded.*)

Answers to Correspondents.

A SUBSCRIBER.— Before making a plan of the house write to the Borough Surveyor for copy of "Bye-laws with respect to Buildings," as there will probably be instructions as to the minimum heights of rooms, area of yard, &c. The plan may be made on drawing paper to a scale of 4 feet to an inch or 8 feet to an inch, and a copy of this on tracing cloth will be sufficient to send to the Borough Surveyor. The original plan may then be used by the builders. Outline in Indian ink, colour the brickwork red (carmine, or crimson lake), using a heavier shade for press bricks (if any), stonework, &c., a light blue, the slates a darkish blue (mix a little Indian ink and blue for this). Other colours are often applied, but those named are quite sufficient. We will endeavour to publish a few articles on this subject in an early number.

A. B.—We appreciate your advice to H. P. to read our journal as one of the best aids to study, but is not this rather superfluous seeing he is a correspondent and consequently a reader of "Mining" already. Nevertheless we thank you for the implied compliment.

SILKSWORTH.—If you will refer to No. 5, Vol. IV. of "Mining," you will see how I arrived at the formula— $D = \frac{P \times d^3}{L \times 18}$ The formula is only applicable when two-thirds of the theoretical power is got from the engine. This is no detriment however as this is the proportion calculated by most authorities on the subject.

WM. STANSFIELD.—Letter to hand.

Answers to Competition Questions.

GIVEN IN No. 21, VOL. IV.

(1) What horse-power would be required to haul 20 full tubs, each weighing 10¼ cwt., up an incline with a rise of 1 in 3½, at a speed of 200 yds. per min., the friction of the tubs being $\frac{1}{50}$ of the weight, and neglecting the weight and friction of the rope?

Answer.—Here we have two resistances, the first that due to gravitation, and the second that due to friction of the tubs. Now there are 2,240 lbs. in a ton, if this value be multiplied by 1 and divided by 3·5 the result will be the resistance of 1 ton due to gravitation—

$$\text{Then } \frac{2240 \times 1}{3{\cdot}5} = 640 \text{ lbs.}$$

and if 2,240 be divided by 50 the result will be the resistance of one ton due to friction—

$$\text{Then } \frac{2240}{50} = 44{\cdot}8 \text{ lbs.}$$

and 640 + 44·8 = 684·8 lbs. due to gravity and friction. Now if 684·8 be multiplied by the number of tons and the speed in feet per minute, and divided by 33000 and the modulus ·7, the result will be the horse-power required.

$$\text{The load in tons} = \frac{10{\cdot}25 \times 112 \times 20}{2240} = 10{\cdot}25 \text{ tons.}$$

$$\text{And } \frac{10{\cdot}25 \times 684{\cdot}8 \times 200 \times 3 \times 1}{33000 \times {\cdot}7} = 159{\cdot}5 \text{ actual h.p.}$$

HENRY CAUSEY.

(2) A pair of winding engines have cylinders 30 inches diameter, and a stroke of 5 feet, and the steam pressure is 60 lbs. per square inch. What is the greatest diameter the drum can be made in order that the engines may be able to lift a load of 5 tons, allowing a margin of ⅛ for overcoming friction?

Answer.—One cylinder only can be taken into account in answering this question, as it may be one crank is on the centre when the load is to be lifted. The question may be dealt with on the principle of the lever, the moments acting at one end being the steam pressure in lbs. by area of cylinder in square inches by twice the piston stroke, and the moments at the other end being the load in lbs. by circumference of drum in feet. These moments must exactly equal one another. I will assume 60 lbs. effective pressure on the piston. A cylinder 30 inches diameter = 30 × 30 × ·7854 = 706·86 square inches. Then with pressure of 60 lbs. in the cylinder—

$$\text{Total pressure} = 706{\cdot}86 \times 60 = 42411{\cdot}6.$$

After allowing ⅛ for friction we only have ⅞ as effective power of the engine to raise the load—

$$\therefore 42411{\cdot}6 \times \tfrac{7}{8} = 28274{\cdot}4.$$

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Let P = total power available and W = weight to be raised.

Motion of P = stroke × 2.

Motion of W = circumference of drum in feet.

$\therefore$ 28274·4 × 10 = 11200 × motion of W.

$$\text{Motion of W } \therefore = \frac{28274{\cdot}4 \times 10}{11200} = 25{\cdot}24 \text{ circumference of drum.}$$

$$\therefore \text{ diameter of drum} = \frac{25{\cdot}24}{3{\cdot}1416} = 8{\cdot}03 \text{ feet.}$$

$\therefore$ the greatest diameter of drum = 8·03 feet, say 8 feet diameter.

GEO. W. HEDLEY.

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(3) Describe how you would set about levelling a dook having a gradient of 1 in 2. Also show how you would level on a gradient of 1 in 25. State your reason for altering the mode of doing the work.

Answer.—I would set about levelling a dook having a gradient of 1 in 2 in the following manner:—Procure a straight edge 6 feet long and an ordinary spirit level, the straight edge should be laid along the road with the spirit level upon it, and then one end is lifted off the ground till it is in a truly level position as shown by the spirit level resting on it; a two-foot rule or other measuring strip is then used for taking the height, the one end of the straight edge is raised and the amount of rise or fall is entered in a book. If the leading end of the straight edge, or the inside going "inbye," has been raised, the road falls, but if the outside end is raised it rises, or suppose the outside end is raised 3 feet from the floor and 6 feet length of straight edge, the rise is 1 in 2. The straight edge is then moved forward another length and the same process is repeated, and so on throughout the levelling. This is only an approximate method of levelling, and too much reliance must not be placed on it. I would proceed to level on a gradient of 1 in 25 by the Dumpy level. A good description and illustration of the same is given in No. 4, Vol. III., of this valuable little book. I don't think there is any need for me to describe the process, only to refer the reader to the above number and volume, and he will find there a clear description of the process of levelling, how to take the back-sights, fore-sights and intermediate-sights as well, and also a method of booking the same, and how to reduce the levels, &c.; also how and why a datum line is chosen. My reason for altering the mode of doing the work is where the strata is highly inclined as 1 in 2, the Dumpy level cannot be used as the focus of the telescope would not show for so short a distance as would necessarily be from the level to the staff.

JAMES LAVERICK.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—Hy. Causey, 28, Alma Terrace, Bottling Wood, Wigan.

Commended.—John Jones, Pelydfryn, Aberderfyn, near Ruabon; T. Graham, Carron Colliery, Shieldhill, Falkirk, N.B.; T. Wallis, Cwm Gwyddon, Abercarn, near Newport, Mon.; J. G. Bell, Evenwood, Bishop Auckland; J. Clarke, Longriggend; T. Hill, Crosby Villa, by Maryport, Cumberland; W. P. Laws, 11, South Street, Murton Colliery, Sunderland; H. Nisbet, Candie, Stirlingshire, N.B.; W. H. Miles, Mardy, near Pontypridd; W. Mitchell, Dalharco, Patna, Ayrshire; C. Graham, South Durham Colliery; R. Murton, Heatherfield Cottages, Limerigg, Slammanan; H. Robertshaw, Drighlington, near Bradford; W. Stansfield, 8, Quality Terrace, Wardley Colliery, near Newcastle-on-Tyne; J. Lyle, Jordan Hill, by Parkirk, Scotland; H. D. Steel, 38, Canal Street, Smallwate, Ayrshire.

Question 2.—G. W. Hedley, Medomsley, R.S.O., Co. Durham.

Commended.—R. Forster, 13, Newbottle Row, Houghton-le-Springs, R.S.O., Durham; W. G. Jones, Mill Terrace, Mason's Road, Gorseinon, near Swansea; J. G. Bell, Evenwood, Bishop Auckland; W. Charnock, The Grove, Standish, near Wigan; T. Hill, Crosby Villa, by Maryport, Cumberland; W. H. Luxton, 18, South Row, Newfield, Chester-le-Street, Durham; A. H. Meakin, Mansfield Road, Eastwood, Notts; J. Jones, Pelydfryn, Aberderfyn, near Ruabon; A. McKew, 4, Ginns, Whitehaven, Cumberland; J. O. Keefe, Amble, Northumberland; J. T. Knight, 36, Lugsmore Lane, St. Helens; R. W. Cuthbertson, Hartington House, Staveley; H. Robertshaw, Drighlington, near Bradford; R. W. Corless, 29, Taylor's Lane, Lower Ince, near Wigan; A. Ratcliffe, 61, Catlow Hall Street, Oswaldtwistle; H. Gunn, 81, Queen Street, Normanton, Ayrshire.

Question 3.—Jas. Laverick, Butterknowle, Co. Durham.

Commended.—R. W. Cuthbertson, Hartington House, Staveley; J. Jones, Pelydfryn, Aberdfyn, near Ruabon; J. T. Knight, 36, Lugsmore Lane, St. Helens; R. Forster, 13, Newbottle Row, Houghton-le-Springs, R.S.O., Durham; R. W. Corless, 29, Taylor's Lane, Lower Ince, near Wigan.

Correspondence.

The Editor will not hold himself responsible for any correspondence, nor will the publishing of it affirm that he holds the same views as the writer.

VENTILATION.

Sir,—Will any of your readers answer the following questions:—1st. What quantity of air will a Guibal fan, 20 feet diameter and 5 feet broad, draw through an airway 10 feet wide, 6 feet high, and 3,000 yards long, when running at 40 revolutions per minute? 2nd. How should a candidate for examination proceed to show on a plan the amount of air in each current, and from what point to point would he measure the different splits. Answers to these two questions will oblige. FIREMAN.

PRIZE ESSAY.

An award of 10/6 will be made for the best Essay on "COAL CUTTING MACHINES."

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

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Editorial Notes.

ALTERATIONS IN OUR JOURNAL.—We wish to remind readers of *Mining*, that commencing with next issue but one, published on November 28th, the title will be altered to *Mining Engineering*, the number of pages increased, and the price Twopence.

COAL CUTTING MACHINES.—There seems little doubt that in the near future a large proportion of our coal output will be got by the aid of coal cutting machines. Yankee enterprise and English conservatism are clearly demonstrated by the fact that Americans have for some time past recognised the worth of machinery for coal getting, whereas we are only in the experimental stages in this country. The mines inspector's report of Ohio (U. S. A.) for the past year, informs us that 164 machines were at work, 82 being worked by compressed air, and a like number by electricity, and that these were responsible for nearly one-fourth of the total production of the state. In many other parts of the United States machines are at work, and plants intended to work a large number of machines are being laid down at many collieries. Coal-cutting machines have never had a favourable trial in this country, it is only by working a number of machines, and by judiciously laying down the plant in the first instance, that the full benefit may be derived from them. At a recent meeting of the Canadian Mining Institute, Mr. W. Blakemore gave the results of some experiments with three pick machines, viz.:—Ingersoll, Harrison, and Yoch. The machines were all driven by compressed air and were tried in a 8 feet seam of fairly strong bituminous coal. After carefully watching the tests, Mr. Blakemore concluded that under the existing condition of the mine in which the trial was made, they were capable of producing a larger tonnage of coal in a given time, and at less cost than by any other method. With reference to the respective merits of the machines he said that there was very little to choose between the three. The Yoch machine which is the heaviest and has the largest cylinder is no doubt the best adapted to very hard seams. To compare the results achieved by the machines, however, with the work done by an ordinary coal cutter shows a considerable difference, for the machines averaged 134 tons per day, and a pair of cutters, who load their own coal 12 tons; but assuming that the process of loading represents half the labour (an excessive estimate) their cutting would only represent 24 tons. Referring to the cost of machinery, &c., he said that the result of nine months' experience lead him to add about 10 cents. to the ton to cover cost of maintenance of plant, pipe-ways, repairs, depreciation, and interest on cost.

THE NORTH STAFFORDSHIRE INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—The annual meeting of the members of this institute was held at Stoke-on-Trent, on the 19th inst. Mr. Joel Settle was appointed president for the ensuing year, and in his inaugural address referred to various matters affecting the mining industry. Prof. Clowes, D. Sc. exhibited the Clowes-Redwood portable apparatus for the detection and estimation of carbonic oxide in the air. After the day's business the members attended the annual dinner.

COAL MINING IN CALIFORNIA.—On the trade of San Francisco it appears that the quantity of coal consumed in 1895 was greater than in any year since 1891. This is mainly attributed to the low prices which have ruled, and which are said to be the lowest known, and in part also to the somewhat greater activity of manufactures. It is thought that these low prices will prevail for some time to come. The best grades of steam coal in Australia were quoted at 1·75 per ton, and freights from there were much reduced. Swansea anthracite coal is becoming popular as a steam producer, and 65,000 more tons were imported in the past year than in 1894. This class of coal is admitted duty free, while bituminous coal pays 40 c. a ton. Crude oil is being used at several factories for reasons of economy, but with coal at present prices the saving is said to be slight. Gas companies are liberal consumers of this oil, which, combined with anthracite, is an economical gas producer. Very little bituminous coal is used in making gas. It is feared in some quarters that the low prices of Australian and English coal will materially interfere with the Northern collieries of the State and cause a diminished output. At the same time the developments of the Corral Hollow mines have been progressing rapidly. A railway will soon connect them with Stockton, and it is expected that they will supply an abundance of cheap fuel to this city and neighbourhood. The following table shows the sources from which for the last four years the coal supply has been derived. The table includes all arrivals by water at San Pedro, Los Angeles, San Diego, and Santa Barbara, amounting to 199,130 tons.

	QUANTITY IN TONS.			
	1892.	1893.	1894.	1895.
British Columbia.	554,600	588,527	647,000	651,295
Australia	314,280	202,017	211,733	268,960
English & Welsh.	210,660	151,269	157,562	201,180
Scotch	24,900	18,809	18,636	4,098
East Cumberland & Anthracite...	35,720	18,960	16,640	26,863
Settle-Franklin & Green River ...	164,930	167,550	153,199	150,888
Carbon Hill and South Prairie...	218,390	261,435	241,974	256,267
Mount Diablo and Coos Bay	66,150	63,460	65,263	84,954
Japan, &c.....	4,220	7,758	15,637	9,015
Total...	1,593,850	1,479,785	1,527,754	1,653,520

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Coal Mining in India.*

SINGARENI COLLIERY.

THE Hyderabad (Deccan) Company, Limited, are the proprietors of this mine. It is situated at Yellandu, 157 miles from Secunderabad, in the territory of His Highness the Nizam of Hyderabad (Deccan). Yellandu is the terminus of a sixteen miles branch railway from Dornakal junction, the Nizam's Guaranteed State Railway. The principal officials of this mine are:—The agent and general manager in India, the manager and three assistants to the manager. The manager and one of his assistants have English mine manager's certificate. The other officials include four underlookers who have complete charge of the mine under the assistants to the manager; four night overmen, and a number of Makadams who assist the overmen, secure the roof, fire shots, &c. The contractors also employ officials to supervise their work. The underlookers are not Englishmen, some are natives and the others Eurasians.

Inspections and Reports.—The mine is worked by a succession of eight hours' shifts, but when there is a cessation of work, an inspection of the mine is made just before the commencement of the following shift. A regular periodical inspection is made during one of the shifts in each twenty-four hours, in addition to numerous casual inspections. The principal inspections are made by the assistants to the manager, and the underlooker's inspection comes next in importance. Each of the assistants to the manager makes a daily report in a book kept at the surface of his own section of the mine, in which is recorded the condition of the ventilation, roof and sides, and general safety of the underground workings, and particulars of the output and work done at the mine during the previous twenty-four hours. This report is written each morning, and a duplicate copy is sent to the manager. The mechanical engineer, or his assistant, makes a daily and a weekly written report as to the condition of the machinery, ropes, boilers, &c., and including everything pertaining to the winding shafts.

System of Working.—The thickness of the seam —King seam—is from 3 to 7 feet, most often about 5½ feet, average about 6 feet. The system of working out the coal is the bord and pillar or pillar and stall. The bords and levels are 12 feet wide, and the pillars are formed so as to be uniformly 18 by 12 feet throughout the mine. The mode of breaking down the coal is to uudercut it at the bottom to about 3 feet deep, cut one side to the same depth, and then blast the coal down by at least three shots in a working face, each shot having a charge of 4 oz. of English blasting powder. All the coal throughout the mine requires to be loosened by blasting.

Ventilation.—The air for the ventilation of the mine was, at the time of Mr. Grundy's visit, generated by a small fan, a small furnace and exhaust air from underground engines. Preparations were being made for the erection of a large Schiele fan for the ventilation of nearly the whole colliery. The air was being directed below ground by substantial stone stoppings formed of double walls with dirt between; also by air crossings, wood doors, and brattice sheeting for directing the air to some of the working places.

Blasting.—From 20,000 to 30,000 shots are fired per month, and in almost all matters appertaining to blasting the practice is very similar to the requirements of the English mining law.

Timbering.—The roof of the seam, next above the coal, is generally of such a sound nature that not much timber is required. The timber found to be best for underground purposes is known as "Tirmani timber."

Output.—It appears that the output per hewer per shift is about from 11 cwt. to 12½ cwt. The output per person employed below ground is about 5 cwt. The output for each person employed at the mine is about 4½ cwt.

Pujás.—It is worth noting here that there are 13 pujá days in the year, and these are fully given up to the workmen as holidays. These pujá days happen as follow:—1 in January, 1 in February, 3 in March, 3 in July, 1 in September, 2 in October, and 2 in November. The months of April, May, June, August and December are free from pujás, and the people work on almost every day of those months, except on Sundays, which are always holidays. When the great variety of people and castes working at this mine, and their great number, are considered in relation to the many things affecting them, their behaviour and desire to work at the mine, involving living under such circumstances is really remarkable.

* From Mr. Grundy's H.M.I.M. Report.

Book Review.

THE DETECTION AND ESTIMATION OF INFLAMMABLE GAS AND VAPOUR IN THE AIR.—By Frank Clowes, D.Sc., F.D.C., Prof. of Chemistry, University College, Nottingham, with a chapter "On the Detection and Measurement of Petroleum Vapour," by B. Redwood, F.R.S.E., F.I.C. Crosby, Lockwood, & Son.

This book briefly sums up the results of the author's investigations for several years. The greater part of the matter has been published in the proceedings of several of the scientific societies, but a portion of it is now published for the first time. The intention is to bring the information together in a connected form and to render it more generally available. In addition to the chapter by Mr. Redwood, is included a summary of Dr. Haldane's work in connection with the provisions, properties, and the detection of carbonic oxide. The book is splendidly got up, is fully illustrated, and is certainly a very valuable addition to the previously scanty supply of literature on the subject. There have been many valuable papers—a large number of which have been contributed by Prof. Clowes—read and published in the past few years, but they have been so scattered and inaccessible as to detract considerably from their value to the public.

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The World's Coal.

THE accompanying charts show in a very comprehensive manner the highly developed state of our own coalfields as compared with those of other countries.

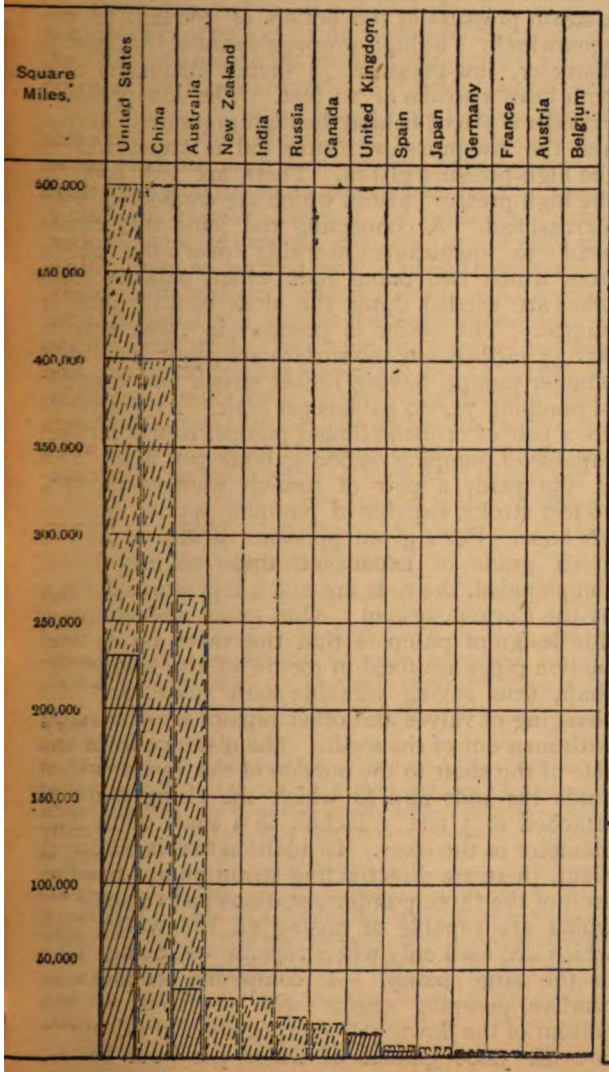
The areas of the principal coalfields of the world are denoted by the first chart. The firm-line shading represents so many square miles of what may be termed actual proved coalfields. The additional areas shown by the dotted-line shading denotes the probable extent of improved fields. It must be understood, however, that many of those shown as probable coalfields have been proved to a certain extent. For example the Canadian coalfield which is denoted on the chart as being about 18,000 square miles in area has been proved in many places and the total area will probably exceed this amount.

It will be noticed that the coalfields of the United Kingdom are insignificant in area as compared with those of United States, China, or Australia but reference to the other chart shows the United Kingdom as the largest coal producing country in the world. Although China has probably the second largest area of coalfields in the world it remains as yet practically undeveloped.

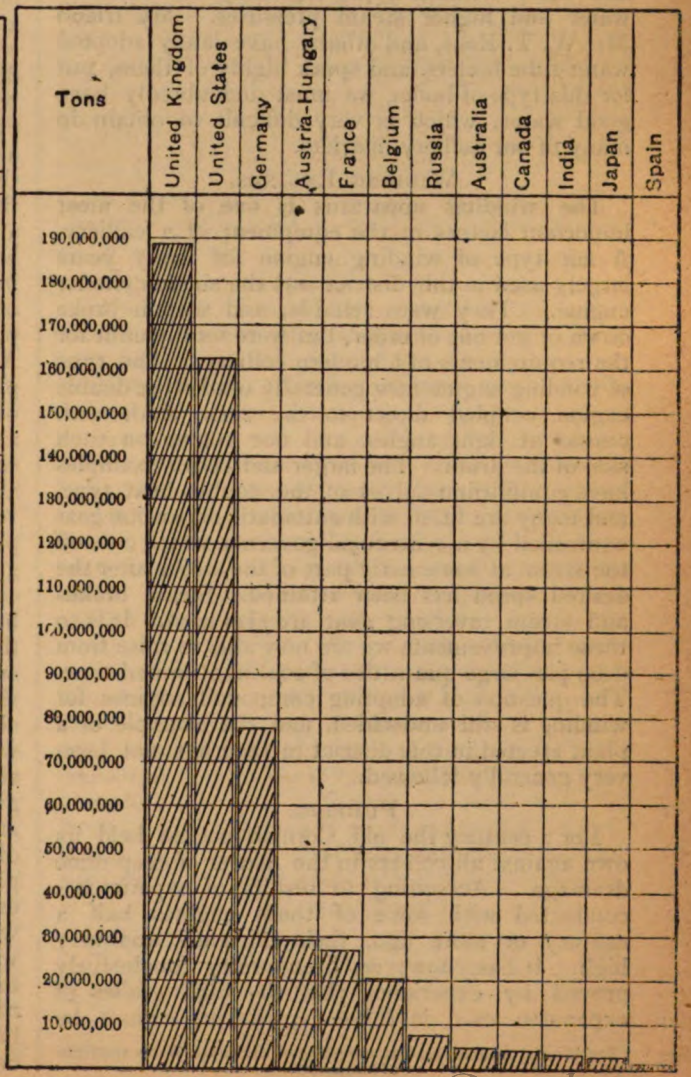
Of course the areas only allow of approximate comparison, because the thickness of coal under each square mile of coal-measures may be three times as much in one as in the other.

The coal production of each country is taken for the year 1894 as more recent statistics were not available in many instances; some also are only approximately correct.

The World's Coalfields.



The World's Coal Production.



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Mining Appliances—Past and Present.*

By Mr. W. H. MARTIN.

Boilers.

EIGHT, and even ten per cent. of the output of coal is often consumed at collieries where large quantities of water have to be pumped, and where there is an extended system of mechanical haulage. This is a serious item in the cost of working, and is a matter that leaves ample scope for engineers to consider and devise improved methods by which greater economy in the generation and consumption of steam can be exercised. Formerly the plain cylindrical boiler with egg ends and with an external furnace was universally used, but for many years past they have been almost entirely superseded by the Cornish and Lancashire types, which are more economical, and have proved to be a much safer and more durable type, especially with inferior water and higher steam pressures. My friend Mr. W. T. Rees, and others, have lately adopted water tube boilers, and speak highly of them, but for this type of boiler we must undoubtedly have good water, which is very difficult to obtain in many of our colliery districts.

Winding Engines.

The winding apparatus is one of the most important factors in the equipment of a colliery. A fair type of winding engine for many years largely used in this district was the single cylinder engine. They were reliable, and seldom broke down or got out of order, but were totally unfit for the requirements of a modern colliery. The type of winding engine now generally used is the double engine coupled direct to the drum shaft with cranks at right angles, and one engine on each side of the drum. The larger and better examples have equilibrium valves of the double beat type, and many are fitted with automatic expansion gear controlled by a centrifugal governor which cuts off the steam at some early part of the stroke after the desired speed has been attained. Steam brakes and steam reversing gear are also used. It is to these improvements we are now able to raise from deep pits large quantities of coal in a limited time. The question of adopting compound engines for winding is still undecided, and the example of a plant erected in this district in 1892 has not been very generally followed.

Pumping.

For a century the old Cornish engine held its own against all comers in the matter of deep mine drainage. According to results of experiments conducted with some of these engines half a century or more ago, their efficiency was very high. It has, however, been pretty conclusively proved by experience that the high grades of expansion used in these experiments cannot be adopted in ordinary practice for our very deep mines, and for that reason probably, as well as for some others, such as cost and excessive shaft space, the old Cornish engine has latterly been put aside by more economical and more compact rivals. A few years ago a very interesting paper was read by my friend Mr. Hann on "An Outburst of Water, and the means of dealing with it, at the East Elliot Pit, New Tredegar," in which was given a description of a fine example of a duplex direct-acting triple-expansion condensing steam pump put down at the colliery, and which I understand gives excellent results. During the past few years Messrs. Hathorn, Davey & Co., Leeds, have erected in this district some fine examples of their well-know deep mine pumps. They are all of about the same design, and a short description of one erected at the Dowlais Cardiff Colliery will suffice. The engine is tandem horizontal compound condensing, and works with a steam pressure at the boilers of 100 lbs. to the square inch. The high-pressure cylinder is 45 inches diameter, low-pressure 78 inches diameter, and both have a stroke of 10 feet. The low-pressure cylinder is placed behind the high-pressure cylinder, and the low-pressure piston rod is connected to the high-pressure piston. There are two rods to the high-pressure piston which are connected with a crosshead. A connecting rod joins this crosshead to quadrants working over the shaft, from which two pump rods which balance each other are carried down the shaft to the plunger pumps. The water is pumped in three stages. At 155 yards below the surface are a pair of 16-inch plunger pumps, having 10-feet stroke and capable of pumping 75,000 gallons per hour. At 335 yards are a pair of 14-inch plunger pumps, 10-feet stroke, capable of pumping 60,000 gallons per hour, and at 450 yards a pair of 10-inch plunger pumps, 10-feet stroke, capable of pumping 45,000 gallons per hour. For a given pressure of steam, and a given grade of expansion, these engines being compounded, the rods are much less strained than by the Cornish system. One great advantage of this design of pump is that the valve boxes and suction pipes are fixed in rooms off the side of the shaft, thus saving valuable shaft space, and the changing of valves and other repairs are carried on with men out of the shaft. The distance from the side of the shaft to the outside of the byats which guide the rods and to which the rising main is attached is 3 feet 3 inches, in a shaft of 20 feet diameter in the clear. In addition to this pumping plant, there are direct-acting steam pumps fixed at each of the three pumping stations just referred to, which are capable of raising all the water, and which are used only when repairs are being done to the large pump. A compound condensing rotative pumping engine will be fixed at the bottom of the downcast shaft, capable of raising in one lift 5,000 gallons of water per hour to the

* Presidential Address read at a meeting of the South Wales Institute of Engineers.

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10-inch plunger pumps, a height of 840 feet. This pump is arranged to work either by steam conveyed down the pit from the surface or by compressed air.

Compressed Air.

One of the earliest examples of the use of compressed air for mining purposes in this district was that of a pumping plant at the Mountain Four Feet Pit at Dowlais. It was erected in the year 1859. As may be expected, at that time it was by no means well designed, having three inches clearance at each end of the air cylinder. The steam cylinder was 25 inches diameter, the air cylinder 26 inches diameter, and the stroke in both cases 4 feet. The working pressure of the air was 30 lbs. per square inch. This old plant did good service for many years, and was no doubt the most convenient method then known for doing the work of pumping from a drift several hundred yards from the bottom of the shaft. About twenty-five years ago the use of compressed air for hauling and pumping purposes was considerably extended, and several engines by the best makers were built and erected in this district. These engines still left much to be desired with regard to economy, both in the use of steam and in compressing the air. Much has been done during recent years to effect these economies, by using higher steam pressures, greater rangers of expansion, compounding the engines, and by condensing the steam. Also by improved designs and construction of the valves of the air cylinders, and the still more recent improvement of stage compression of the air, and the extraction of the snrplus heat produced during compression by passing the air through a cooler between the two cylinders. Two air compressors of this description have recently been erected, one at Messrs. Lewis, Merthyr, and one at Dowlais Cardiff Colliery. Whatever is done to keep down the temperature of the air during compression, there will always be great loss in converting the heat energy of steam into the form of compressed air, but I am convinced that the very low efficiencies of compressed air plants have often been due to avoidable defects, which have in many instances been remedied in the newer installations. Of the several methods for obtaining power for hauling and pumping underground, more especially in gaseous mines, compressed air is undoubtedly the most convenient and the safest. It can be conveyed to any distance, and used at any point in a mine beneficially rather than otherwise, and on this account is on the whole superior to its younger and most formidable rival, electricity. It is preferable, except in point of cost, to the objectionable use of underground steam boilers, or even the less objectionable system of conveying steam down a shaft, which in well-covered pipes can be conveyed for a distance of half-a-mile without very serious loss. The system of transmitting power undergrouud by means of ropes from engines erected on the surface has in this district only been adopted in more or less shallow pits, and a new installation now being erected by Mr. Hann at the Penrhiwceiber Colliery, where the shafts are about 600 yards deep, is, I think, a step in the right direction, and is one that will be watched with keen interest by many of us. For haulage on the main roads it will probably prove to be a very satisfactory arrangement, both in simplicity of working and in point of cost.

Haulage.

Mechanical wire rope haulage is generally done on one of three systems, viz.: "single rope," "main and tail" and "endless rope." It depends upon various conditions which system is adopted. All have been used for a great number of years, and any changes and improvements made have been in the details. One great drawback to the use of the endless rope haulage system in this district is the difficulty of maintaining wide roadways. There is no uniformity at the collieries in this district as to the gauge of road, the weight of rail, or the size of tram used, as of course much depends upon local circumstances. At Dowlais Cardiff Colliery it has been decided to use a 3 feet 2 inch gauge, the main roads laid with rails 35 lbs. to the yard, well fished and having steel sleepers one yard apart, and a tram capable of holding 45 cwts. of coal.

Ventilation.

Ventilation of all large collieries, with few exceptions, is now effected by one or other of the centrifugal type of fans, such as the Schiele, Walker, Waddle, Guibal, Capell, and others. Seeing that each design has its advocates, it would be invidious to select either for preference. No doubt each has some advantage either in point of first cost, simplicity of construction, efficiency and economy in the performance of work, durability or freedom from derangement. Either is a marked improvement on the old system of furnace ventilation. Designers of these ventilators vary considerably in their methods of driving. Some use toothed gearing, others belts, others prefer ropes, while others couple the engine direct to the fan shaft. An improvement which gives great steadiness in driving is to couple a pair of engines, one to each end of the crank shaft at right angles, instead of the single engine generally used, and I have no doubt that the fans of the slow revolving large diameter type could be driven with advantage in this way, that is, with a pair of engines rather than with the single engine in the ordinary manner.

Damping Dust.

The danger of dry coal dust in our collieries is now almost universally acknowledged by mining engineers, who have for some years past given the question of damping dust their best attention. Sprays, or jets of water under high pressure, are

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commonly used, and better still the system of producing a watery vapour, which is obtained by the mixture of compressed air and water under pressure, issuing through a fine orifice. It is only by the latter system, which is employed at several collieries in this district, that the current of air itself is perfectly saturated, and the dust lurking in the roof and sides as well as the floor is effectually damped, and the temperature of the air considerably reduced. As I recently read a paper upon this subject I need not further refer to it.

Screens.

The importance of efficiently screening and cleaning the coal at the pits cannot be over estimated. This matter has recently been written upon and fully discussed at our meetings, with good results. For many years the screening and cleaning equipment of a steam coal colliery consisted of a simple fixed flat bar screen inclined at an angle of about 27 degrees, on to which the coal was discharged from the tram, the small coal falling between the screen bars, while the large was carried over the end of the screen into the wagon; no provision being made for cleaning. Screens were afterwards hinged and balanced so that the empty screen would always stand in a horizontal position and be held there by a brake whilst the coal is tipped upon it, examined, and cleaned; the trams being generally tipped endwise. Modifications and improvements in the form, the balancing, and in the provision for examining and cleaning the coal on this class of screen have been made by Mr. R. Jordan, who fully described them in a paper he read before the Institution in 1894. At many of our steam coal collieries, side tipplers for the trams, and long travelling plated picking bands for cleaning the coal, are fast taking the place of the old system, with very beneficial results. At the Dowlais Cardiff Colliery, the tram of coal, after leaving the cage, will gravitate on an inclined road to a creeper, which will haul it over the weighing machine, the motion of the creeper and that of the tram being under the control of the weigher. From this creeper the tram will gravitate to one or other of the side tipplers, which are operated mechanically, and which will discharge the coal over a fixed screen to a travelling cleaning band 45 feet long by 5 feet wide, having a balanced loading end for distributing the coal into the wagon, and thus avoid breakage.

Pithead Framings.

Pithead framings, for the sake of durability and immunity from damage, or destruction by fire, are now generally made of wrought-iron or mild steel. Those erected at the Dowlais Cardiff Colliery are 72 feet high from the landing to the centre of the pulleys. They have four legs, each 18 inches square, box section, formed of four angles 4½ inches by 4½ inches by ⅝ inch, plated on three of their sides with steel plates ⅝ of an inch thick, and the fourth side being formed of single lattice work 3½ inches by ⅝ inch; the four legs are well braced together both horizontally and diagonally. Back stays, 3 feet deep 18 inches wide, extend from the top of the back legs to the engine bed, the top and bottom booms of which are each made of two angles 4½ inches by 4½ inches by ⅝ inch, and two plates 18 inches wide by ⅝ of an inch thick, the two sides being formed of single lattice work 4 inches by ⅝ inch. The two back stays, which are 175 feet long, are braced in the same manner as the legs, and they are supported at the middle of their length by a pair of struts.

Pithead Pulleys.

Pithead pulleys should be made of large diameter, as light as possible consistent with rigidity, and should run perfectly true. As a rule they are made with cast-iron rim and boss, and with wrought-iron arms. Pulleys of 20 feet diameter made entirely from wrought-iron are working at the Deep Navigation Colliery, with, I believe, good results.

Conductors.

Wrought-iron round bolts and long linked chains were amongst the earliest forms of cage conductors, some of which still survive. Conductors were afterwards, and are now made of wood. They have also been constructed of iron in channel, tee or angle sections. A good conductor, and one that has been extensively used for many years, and in the deepest shafts, is formed of tee head iron or steel rails, clipped to byats, and fished together and dowelled at their ends. Generally two rails only are used to each cage, and shoes are fixed to the cage of such a form as to loosely embrace the head of the rail and slide up and down upon it. Every rail should be independently supported on the byats, with a small space at the ends to allow for expansion. This class of conductor is no doubt expensive in first cost, but it is efficient, reliable, and durable. Wire rope guides made of cold drawn mild steel, with division ropes to prevent the cages striking each other, seem to have the largest share of favour at the present time, especially where there is sufficient room in the shaft to admit of a little oscillation of the cages. It is proposed to use this class of conductors at the Dowlais Cardiff Colliery, where the depth of the shafts is 740 yards. There will be four conductors, each 1¾ inch diameter, to each cage, and two division ropes, 2½ inches diameter, between the cages. With regard to the supposed difficulty of changing steel rail guides, I may mention that at Bedlinog Colliery, four lengths, each of 580 yards, were lately renewed at the rate of one length of 580 yards in sixty hours.

(Concluded.)

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Chesterfield & Midland Counties Institution of Engineers.

A SPECIAL MEETING of the members of the above was held at the University College, Nottingham, on Saturday, October 17th, 1896, Mr. M. H. Mills in the chair as president.

HOW A MINE MAY BE DRY, BUT NOT DUSTY.

The discussion of Mr. G. Fowler's paper on the above reached a very interesting stage. The question of fast-ended trams received much attention, and it was said that they would be most detrimental to the interests of the coalowners and that there would be 20 per cent. more small coal.—Mr. Fowler replied to the questions seriatim, those asked at this meeting and those which have already appeared in this journal. He remarked that the reason for him writing that paper was in consequence of a paper written by Mr. Harman (a German). Mr. Harman's plan was that they should have an adequate means of laying the dust in mines by water. He also gave figures as to the approximate cost of putting into effect the scheme in the colliery with which he was connected. His (the speaker's) paper was designed as an answer to Mr. Harman's scheme, and he was quite convinced that the suggestions he had submitted would eventually be adopted, and that the main roads of collieries in this country would be kept clean and practically free of dust. Mr. Harman stated that he had spent £10,000 on his colliery in providing arrangements for watering. A similar scheme if put into operation at the Cinder Hill Colliery would cost from £20,000 to £40,000. His idea in writing that paper was to suggest a simpler plan. With regard to Mr. Lewis's criticism, when he (the speaker) first became connected with Cinder Hill Colliery, 25 years ago, they used nothing but open-ended tubs there, and he found that they had dreadfully dirty roads. He thought he would effect an improvement in that respect, so he had the ends of the tubs closed. It was then suggested to him that the fast-ended tubs might have an effect in increasing the production of the slack, and to test the matter be had open-ended and fast-ended tubs worked in the same stalls for weeks in succession. He found that there was no difference in the two kinds of tubs so far as the production of slack was concerned. He quite agreed that tubs did not cover the whole of the question. He had shown in his paper that he had not lost sight of the financial aspect of the question. The cost of making the road smooth in the Cinder Hill Colliery was exactly half of the amount estimated for that purpose, namely, £37 10s., instead of £75. He mentioned that as showing that if they wanted to make their roads smooth they need not spend a lot of money. Mr. Longden had asked him to give some particulars relative to the recent accident, arising from the use of bellite, in the Newcastle pit, one of the Babbington group of collieries. Bellite was a very high explosive and could only be used by means of a detonator. It was a dangerous thing to handle, and special care had to be taken in using it. The manufacturers of bellite would tell them that they ought to put at least six inches of soft stuff on the charge before commencing to ram it. One of the men at the Babbington pit forgot the proportion, and having put about an inch of soft clay on the top of his cartridge, connected with which was a detonator, he commenced ramming the charge, with the result that it exploded, and the man was badly injured. He was now lying in the Nottingham General Hospital, but he had acknowledged that he alone was to blame for the accident.—The President remarked that Mr. Fowler's paper was a most valuable one, and the thanks of the members were due to him for the same.

THE CAUSES OF DEATH IN COLLIERY EXPLOSIONS.

In connection with Dr. J. S. Haldane's paper on the above—which was ultimately adjourned for further discussion—the opinion of doctors who have been called in at the time of colliery explosions had been invited to contribute their views. The president remarked that some interesting facts had been brought to the notice of the members in the previous discussion on this question. One was the proportion of bodies burnt in an explosion to those not burnt or injured. It appeared that at one or two colliery explosions where Dr. Haldane had been in attendance he had found that 77 per cent. of the victims might have escaped but for the afterdamp, and that the bodies were not in any way damaged. That was an exceedingly interesting point. With regard to the much discussed question of coal dust, Dr. Haldane attributed a large amount of oxygen in the afterdamp to the presence of great quantities of coal dust. Perhaps, after all, this coal dust had a certain value in mines, and it might not be so dangerous as it had been thought to be. The actual cause of death in colliery explosions was carbon monoxide.—Dr. Court, of Staveley, Chesterfield, the well-known expert on miners' nystagmus, said it was perfectly true that bodies found at a distance from the source of the explosion were not badly burnt, but there was nothing that would cause more severe burning than an explosion of gas, if a person was close to the place of ignition. The point was they might get a very severe localised burn which would not cause loss of life, whereas they might get a much less severe burn over a large surface of the skin which would prove fatal. With regard to the question of poisoning by afterdamp, they must bear in mind that carbon monoxide was an anæsthetic, like chloroform and ether. As to the means to be adopted to combat this poison, although the driving out of carbon monoxide by oxygen in a mechanical way was one

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suggested by Dr. Haldane, they must not forget to provide means to restore animation. Theoretically Dr. Haldane's suggestion as to taking oxygen into coal mines after an explosion was a good one, but he thought they would agree that unless they could take it into a mine in a much more portable form than the way it was used, for instance, for a magic lantern, there would be great difficulty in carrying it into a pit after an explosion. He would suggest that in every large mining centre such an institution might be established as the lifeboat institution, where men should be an instant's call ready to risk their lives, men trained in ambulance work and possessing a knowledge as to the method of using oxygen tubes.—Mr. Ashworth said the question of pressure had not been sufficiently considered.—The President mentioned that communications on this subject had been received from Dr. Ransom and Dr. Clowes. The former wrote "Oxygen and artificial respiration, persevered in for a long time, are the best means of saving life in case of poisoning by this gas."—The President suggested that the discussion should be adjourned, and this was agreed to.

THE GOBERT FREEZING PROCESS OF SHAFT SINKING.

Discussion was resumed on Mr. M. A. Gobert's paper on "The Gobert Freezing Process of Shaft-sinking.—The President said this was an interesting and important question. Mr. Gobert had brought before them a new process, which appeared to be far more economical and altogether better suited than any previous process to what would undoubtedly become a necessity in this district. There was no doubt that in their sinking operations in the eastern portion of their coalfield they would have to pass through water-bearing measures, and it would be very difficult to get through them without some such system as Mr. Gobert had devised.—The question was adjourned for further consideration.

ELECTRICITY IN COAL MINES.

Mr. H. W. Ravenshaw's paper on "Precautions necessary in the use of electricity in coal mines," read at the June meeting of the institute, was briefly discussed.

EXHIBITS.

A working model of an automatic safety brake for mine cages, and samples of Johnson's miner's safety lamp were exhibited respectively by Mr. Albert Hemsley and Mr. A. T. H. Johnson.

South Staffordshire Institute of Mining Engineers.

THE twenty-ninth annual meeting of the members of the South Staffordshire and East Worcestershire Institute of Mining Engineers was held at the Mason College, Birmingham, on Monday, the 12th inst. Mr. J. Cooksey, the retiring president, occupied the chair at the commencement of the proceedings.

The report was adopted, and the Secretary (Mr. A. Smith) stated that the report of the scrutineers showed that Mr. R. S. Williamson had been elected president, and Mr. W. H. Whitehouse vice-president.

PRESIDENTIAL ADDRESS.

Mr. Williamson therefore took the chair and delivered his presidential address. He said it was interesting to find that mining engineers and colliery managers had advanced with the times, and were able in the face of great difficulties to get an increased output, though, no doubt, the introduction of improved mechanical appliances had played an important part in the development. The number of fatal accidents in proportion to the number of persons employed continued to decrease, not from the fact that mines were less dangerous to work, but from a higher standard of men, supervision, and discipline. A comparison of the number of accidents with the quantity of coal raised was interesting. In the year 1874, 126,590,108 tons of coal were raised, 538,829 persons were employed, and there were 895 fatal accidents; whilst in 1894 there were 188,277,525 tons raised, 705,240 persons employed, and 813 fatal accidents. Referring to technical questions, he thought that with the present appliances defective ventilation should not be heard of, but careful attention was required to insure the proper circulation of the air. The day was not far distant when the use of naked lights underground would be prohibited by law, and electricity would no doubt form an important factor in lighting. Then all safety lamps should indicate the presence of firedamp and stythe. No doubt explosives were too largely used, more particularly in seams where a large percentage of round coal was not a necessity. He considered that the use of explosives should be subject to the most stringent rules, and, if gas was known to exist, should not under any pretence be used. The standing charges connected with coal mines were so great that any improvement calculated to reduce the cost of working was eagerly looked for. In his opinion, if mining associations and institutions would give good and substantial prizes for labour-saving appliances for use in mines, improvements would be made, and the cost of working reduced. He was convinced that if they were to hold their own with their Continental competitors they would be compelled to give the question more attention. Foreign competition was viewed with contempt by some people, but unless they kept up to the times as far as economical working was concerned the competition would succeed sooner or later.

A vote of thanks to the retiring president and officers having been passed, a paper on

"RECENT BUMPS AND OUTBURSTS OF COAL AT HAMSTEAD COLLIERY"

was read by Mr. F. G. Meachem. He said a new danger had arisen which in the Black Country was known as "bumps," and in Lanca-

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shire and Warwickshire as "outbursts." Though considerable controversy had been raised on the subject, he believed that the two things were the same, and that pressure alone was the cause of the "bumps," but he acknowledged that he was not quite clear on the point, owing to his having heard of "bumps" in some thick-coal pits from 10 to 100 yards deep. By the aid of diagrams he explained "outbursts" which had occurred at various collieries. The method of prevention which was now being pursued, though he could not say with great success, was to drive the road in the middle of the seam, to double timber with supports 18 inches apart, of extra strength and of young larch, and finally to hole the coal in the middle or near the top. The result of this method was that when the holing had reached 2 feet the coal had burst at the back, and no serious injury had resulted to the men nor had the timber broken. He thought that, taken as a whole, the outbursts were due to pressure, and that gas played a very insignificant part. Mr. Meachem was thanked for his paper.

Examination Questions with Answers.

By JOSEPH CARTER, First-class Certificated Manager.

Questions given at the Examination for Certificates of Competency for the West Lancashire & N. Wales District, June, 1895, at Wigan.

FIRST-CLASS.

(*Continued from No. 21.*)

Part II.—Mine Working.

QUES. 13—Describe by sketch, with dimensions, how you would contruct a furnace in a fiery mine, 600 yards deep, where 150,000 cubic feet of air per minute is required. Show upcast shaft.

ANS.—I should build a furnace as described below. The outer case or arch walls to be 18 inches thick and packed behind the arch with 18 inches of fine sand. Inside this outer casing the furnace flues are built (see figs. 1 and 2), leaving a space of

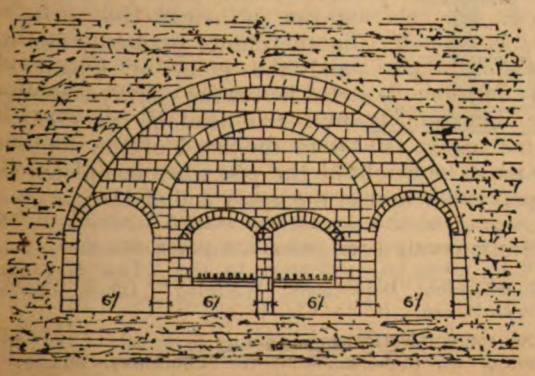

Fig.

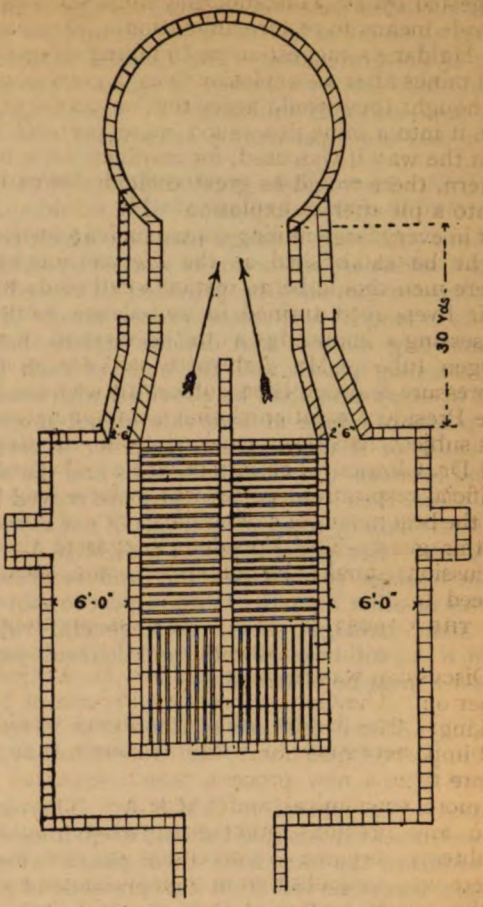

Fig. 2.

2 feet 6 inches on each side between the floor and outer wall, for ventilation and examination at any time. Underneath the whole area of fire-bars I would put an iron pan, 6 or 8 inches deep, and keep it filled with water so that the ashes are easily and speedily cooled. Fig. 3 shows the arrangement

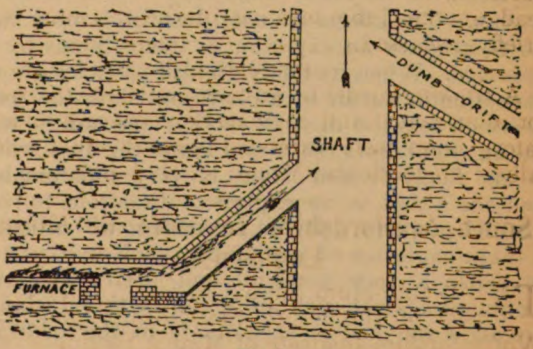

Fig. 3.

at bottom of upcast shaft. A furnace to produce 150,000 cubic feet of air per minute would require a fire-grate area of 150 square inches. A well-

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constructed furnace is considered capable of yielding about 1,000 cubic feet of air per minute per square foot of fire-grate area. The furnace as described would be 6 feet by 12·5 feet = 75 × 2 = 150 square feet area, and this multiplied by 1,000 = 150,000 cubic feet of air per minute as required.

QUES. 14.—What requirements have to be observed in a main haulage road?

ANS.—All main haulage roads on which persons travel, which are self-acting or worked by an engine, windlass or gin, shall be provided (if exceeding 30 yards in length) with some proper means of communicating distinct and definite signals between the stopping places and the ends of such plane, and in every case shall be provided with manholes for places of refuge at intervals of not more than 20 yards, or if there is not room for a person to stand between the side of the tubs and the side of the plane, then (unless the tubs are moved by an endless chain or rope) at intervals of not more than 10 yards. See general rule 15, C.M.R.A., as to main haulage roads when the load is drawn by horses or other animal. With respect to shot-firing in main haulage roads, then general rule 12, C.M.R.A., sub-heads (*h* and *i*) and their sub-sections 1 and 2 must be observed.

QUES. 15.—Under what conditions would you deem it necessary to withdraw men from their places?

ANS.—See general 7, C.M.R.A. Therefore in accordance with this rule I should deem it necessary to withdraw the men from their places when any danger was observed from the presence of gas, or from any cause whatever. In the part of the mine so found dangerous the workmen should be withdrawn and not be readmitted into the mine or part thereof so found dangerous, until it is stated by the person or persons appointed (for the purpose of inspection) not to be dangerous.

QUES. 16.—What effects may coal dust produce in a mine, and how would you guard against them?

ANS.—The effects of coal dust in a mine may be to produce an explosion or intensify one by its presence. When its finely-divided particles are set in motion in the air by a blown-out shot, the force of which sets the dust in motion and mixes with the air, the flames reach and ignite the dust, which in its finely-divided state is very inflammable, and the result is an explosion, disastrous to both life and property. By its presence it will intensify a slight explosion of firedamp to such an extent as to cause a very powerful and destructive one. To guard against such an agent as this I should not allow the dust to accumulate in the roadways of the mine, and damp the roadways by the spray system, using only such explosives as are regarded to be practically flameless, and all explosives to be fired by electricity.

QUES. 17.—What are the duties of a manager with regard to colliery machinery?

ANS.—A manager must appoint, according to general rule 5, a competent person or persons to examine, once at least in every 24 hours, all external parts of machinery both above and below ground and make a report thereon. It is his duty also to see that these inspections and reports are made and kept up. Also general rule 24, as to age of persons employed at such machinery; and general rule 31, fencing of all dangerous parts of machinery.

(*To be concluded.*)

A Coal Piling Apparatus.

AN American contemporary (*The Colliery Engineer*) notices the invention of a coal piling apparatus as illustrated in the accompanying figures. Fig. 1 is a side view of the apparatus partly in section, and fig. 2 is an end view of the same. It is

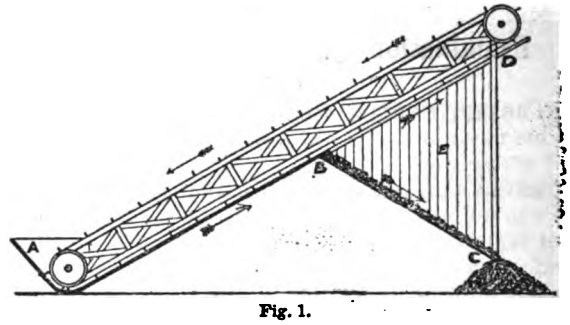

Fig. 1.

designed to pile coal in large conical heaps, the centre of the pile being always at the post, D, and also to handle the coal without allowing it to fall a considerable distance. The coal is tipped into the hopper, A, and is carried up the incline to B by an endless conveyor. It then glides down the chute, BC, and gradually forms a pile around the post. As the pile grows in height the space, E, in the chute, gradually fills up, and the point at which the coal leaves the conveyor changes from the head of the chute at B to the head of the conveyor at D. The height of the pile when completed will equal the height of the upper end of the conveyor.

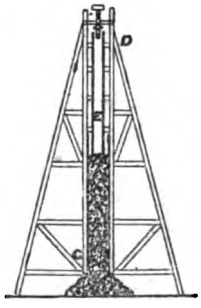

Fig. 2.

Any information respecting Advertisements in this paper will be given on application to the "THE MANAGER," Advertisement Department, "Mining" Office, *Clarence Works*, Wigan.

All communications appertaining to the sale of the paper, agents, etc., to be made to the Publishers, Messrs. E. Marlborough & Co., 51, Old Bailey, London, E.C.

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North Staffordshire Institute of Mining and Mechanical Engineers.

THE annual meeting of the members of this institute was held at Stoke-uponTrent, on Monday, the 19th inst., Mr. Edwin B. Wain, the president, occupying the chair.

The report of the council showed that at the end of the financial year there were 183 members, being three more than at the end of the previous year. The finance committee reported that the income for the past year, compared with the previous year, showed an increase of £118 15s. 8d., the receipts from all sources in 1894-5 having amounted to £204 11s., and in 1895-6 to £323 7s. The expenditure had been £58 14s. 9d. below the income of last year. The reports were adopted. Mr. Joel Settle was appointed president for the ensuing year; vice-presidents, Messrs. J. C. Cadman, H. R. Makepeace, and J. J. Prest; treasurer, Mr. Makepeace; secretary, Mr. J. Richard Haines; council, Messrs. W. N. Atkinson, John Heath, G. P. Hyslop, A. M. Henshaw, James Maddock, J. Newton, F. Silvester, W. Statham, T. E. Storey, G. A. Mitcheson, C. E. de Rance, & B.Woodworth.

PRESIDENTIAL ADDRESS.

The newly-appointed president, Mr. Joel Settle, in his inaugural address, referred to various matters in connection with the working of mines. He observed that engines for winding coal should be of the highest possible workmanship; they should not be too large for the amount of work to be done, and should be provided with the best automatic steam shut-off arrangement, and steam and foot brakes. It was an important matter to supply engines with dry steam, which could be done by erecting a steam receiver to give a regular supply of steam, or an extractor to accomplish the same result. High-pressure boilers should be worked to obtain the best results and effect economy in fuel, and where possible, to have an economiser or some other appliance to heat the water to a high temperature, which would prevent in a great degree contraction and expansion, and give a longer life to the boilers and also be a great saving in labour and fuel. Having expressed his views on the subject of headgears and centralisation of work, he said where the coals were of a bituminous character, coking plant should be erected and the gases utilised for generating steam. This had the effect of reducing the consumption of coal and provided a profitable use for slack. He next spoke of the importance of suitable screens and of coal washing, also of the advantage of a recent application for relighting miners' safety lamps by electricity without opening them. Speaking of ventilation of mines, he urged that the time had arrived when it should not depend upon a furnace but upon mechanical contrivances. Furnaces were dangerous to work when placed near a seam of coal. It was imperatively necessary that the ventilation should be split reasonably into districts, particularly in cases of mines subject to spontaneous combustion, so that any one district could be closed off without affecting others. On the subject of gob fires, he said mines which gave the most trouble, and were most liable to spontaneous combustion were those which had a hussle or carbonaceous shale above or underneath the seam of coal, and great care should be exercised in the working of such mines, whether they had ever had gob fires in the seams or not. In such seams the goaf should not have too much ventilation passing through it, as it induced spontaneous combustion, and waste goaves were better sealed off with stoppings. It might be thought that such goaves would form gasometers in the colliery, but such was not the case, as gases were well known to be harmless unless mixed with certain proportions of air, and such stoppings could be ventilated so that the gas given off could be detected. The fundamental principles to be observed were—not to try to work out too large a district at once; districts should be worked out as quickly as possible, and sealed off when finished, whether they had taken fire or not; sufficient support should be left so as not to disturb sealed-off districts; preparatory or temporary stoppings should always be erected; the quality of gas given off from a goaf should be carefully noticed; change in temperature from the goaves should be noted; more ventilation should not be passed through a district than was sufficient to keep the working-places and gob edges free from gas. In the course of his remarks on the new Mines Regulation Act—some of the provisions of which he explained—he said there was now a widespread opinion that gunpowder was the most dangerous explosive for use in fiery and dusty mines; and although it had been abandoned to a great extent, it was probable that its use would be further restricted by order of the Secretary of State. It behoved colliery managers to ascertain which was the best so-called safety explosive for use in the particular mines required. With reference to coaldust, the watering or efficient damping thereof appeared to be a question awaiting solution, and it might be disputed in some places whether it was practicable to deal with it by water or any other method to render it harmless. There were several seams where watering would be ruinous, and as yet the experience gained was not sufficient to show that the desired result had been attained. He urged the importance of extending the ambulance classes to every colliery in the district. In conclusion, he said many of the existing collieries in North Staffordshire would either be exhausted within the next twenty years, or their output would have to be got with greater difficulty than at the present time. There were several large pounds of water in the coalfield which would constitute more serious difficulties and dangers to mining in the future. For instance,

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the deeper measures in the Chatterley district were at present water-logged, and would eventually have to be dealt with, and a central plant for dealing with the water would have to be provided.

A vote of thanks was accorded to the president for his address, and also to the retiring president.

HYDROGEN TESTING APPARATUS.

Professor Clowes, D.Sc., University College, Nottingham, exhibited the Clowes-Redwood portable apparatus for the detection and estimation of carbonic oxide in the air. He explained in detail the principle of the apparatus by the aid of lantern slides. He stated that the apparatus had been designed for testing coal gas containing carbonic oxide, and also water gas. If intended for use in mines, it could readily be converted to a safety apparatus.

A short conversation took place, and Dr. Clowes received a vote of thanks for having exhibited the apparatus.

A number of other objects of interest relating directly or indirectly to mining were shown, and after the business had been concluded, the members of the institute attended the annual dinner.

Prize Competition.

We offer the sum of £1 1s. 0d. to the sender of the best design for

WORKMEN'S COTTAGES.

The plans must be made in Indian ink only, and consist of Elevation Section, Ground Plan, and Floor Plan of one cottage with principal dimensions. An abridged specification must accompany each plan, and the cost of erecting, in series of say 8 or 10, must be given. Preference will be given to designs of cottages actually in existence and built by a colliery company. We reserve the right to publish non-successful plans, and to withold the award if there are none suitable for publication.

Plans, &c., to be sent in not later than November 14th, 1896.

Correspondence.

MENSURATION.

Sir,—In answer to R. J., I beg to submit the following:—

Question.—Find area in acres, roods, and poles of a coal-field having four sides, each side containing 60 chains, and having a seam of coal 3½ feet thick, with an inclination of 1 in 2. Find the number of tons in the field, taking 32 cubic feet to equal 1 ton.

Answer.—I. By squaring the length of sides equals the area of the field $60^2 = 3600$ square chains, or 360 acres area of field.

II. Beneath this area there is a coal seam 3½ feet thick, dipping 1 in 2, which means for each 2 feet we go horizontally we must drop 1 foot vertically to keep on the seam. Then a drift driven from one end of the royalty to the other, following the full dip will be 67 chains, $\therefore \sqrt{2^2 + 1^2} = 2{\cdot}23$, and as $2 : 2{\cdot}23 :: 60 : 66{\cdot}9$, or say 67. Each chain is 66 feet in length, then the area of the seam in square feet will be $(60 \times 66) \times (67 \times 66) = 17,511,120$. And the thickness of the seam being 3½ feet, the number of cubic feet of coal in the field will be $17,511,120 \times 3{\cdot}5 = 61,388,920$ cubic feet of coal, and as 32 cubic feet is equal to a ton, $61,388,920 \div 32 = 1,918,403$ tons 15 cwts. Hoping the above will be of service to R. J. and others. JOHN N. WARDELL.

H.-P. OF BOILERS.

Sir,—Will any of your readers kindly answer the following through the medium of your paper. What is the horse-power of a boiler, 8 feet diameter, 30 feet long, and working at 90 lbs. pressure per square inch, having 32 Galloway tubes, also the thickness of tube plates and thickness of boiler plates. CONSTANT READER.

VENTILATION.

Sir,—What quantity of air would a Guibal fan, 20 feet dia. and 5 feet broad, draw through an airway 10 feet wide, 6 feet high, and 3,000 yards long, when it was running at 40 revolutions per minute? Co-efficient of friction per square foot of rubbing surface = ·0217 lbs. of pressure per square foot of section for a velocity 1,000 feet per minute. State approximately the difference of the co-efficient of friction for three airways of similar dimensions:—A, lined with crowns and props; B, roof and sides unlined; C, brick arch. PARTICK.

[Awards will be made for the best answers to the above two questions.]

Answers to Correspondents.

MINING FORMULÆ.—Will the sender of the contributions thus headed please send his name and address.

W. H. AND OTHERS.—We are pleased to be informed that the proposed alteration meets your views, and we are to have your continued support.

Award for Essay.

R. W. Cuthbertson, Hartington House, Staveley, near Chesterfield.

Commended.—G. Daykin, 24, High Gurney Villa, nr. Bishop Auckland; C. Gregory, Bransty Villa, Whitehaven, Cumberland; C. C. Greene, Eldon, near Bishop Auckland; L. Rowe, Camborne Mining School, Cornwall; R. Anderson, 25, West Terrace, Newfield, Chester-le-Street, Co. Durham; J. E. O. Keefe, Amble, Northumberland; E. Hughes, 23, George Town, Tredegar, Mon.; R. Forster, 13, Newbottle Row, Houghton-le-Springs, Durham; J. G. Bell, Evenwood, Bishop Auckland; J. Finch, Green Lane, Hindley Green; J. Lawson, Pavilion Terrace, Burnhope Colliery; T. Graham, Carron Colliery, Shieldhill, Falkirk, N.B.; J. C. Binks, Sandhill, Rawmarsh, Rotherham; W. Mitchell, Dalharco, Patna, Ayrshire, N.B.; G. C. Robbings, 9, Lewis Terrace, Llaubradach; W. Slocombe, 11, Thorne Avenue, Newbridge, Mon.

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'Mining'

A Paper devoted exclusively to the interests of the Mining Community.

Edited by T. A. O'DONAHUE, assisted by J. CARTER.

No. 26. Vol. IV. Nov. 14th, 1896

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Editorial Notes.

ALTERATIONS TO "MINING."—As previously announced the next issue of the mining journal published from these offices will appear under the more descriptive and expressive title of "MINING ENGINEERING." It will contain a larger number of pages than "Mining" does, be enclosed in a coloured cover, and will be issued at the price of Twopence. Several new departures are being made with respect to the contents to enhance its value, and to make it invaluable to the mining engineer and colliery manager. Students also will find that their department is not neglected, and a series of articles on "Mining Mathematics and Mechanics," by the Editor, should prove useful. "Mining Engineering" will be published on the 28th inst.

THE COAL OPERATIONS NEAR DOVER.—An interesting ceremony was performed on Friday, the 23rd inst., at the Kent Coalfield Works, near Dover, when Mr. Francis Brady, engineer of the South-Eastern Railway Company, with whom were Mr. G. P. Simpson and Mr. N. R. Griffith, started the second colliery shaft, which is about 200 feet to the east of the first pit. The new shaft, which is named the Simpson Pit, the first being known as the Brady Pit, is 24 feet in diameter, which with 2 feet bricking will provide a finished shaft of 20 feet diameter. The works are now extending very rapidly, nearly a hundred new sinkers and others being employed. The No. 1 pit reached a depth of 360 feet last week, when the work was stopped, owing to water finding its way into the pit. This has led to some interesting tests. It has been found that the water found its way through the loose stratum from the old experimental borehole sunk by Mr. Brady for over 2,000 feet, and that the flow came from below. The temporary gear at the mouth of the pit is now being replaced by more powerful and permanent machinery, and as soon as this is completed and a pump fixed, the sinking at No. 1 pit will be continued. Mr. Brady expects to reach the first coal by the end of next spring.

THE EDUCATION OF MINING ENGINEERS.—A General Meeting of the members of the Midland Institute of Engineers was held on the 24th ult., at Leeds, and amongst other papers discussed was that of the president (Mr. G. Blake Walker, J.P.) on "The Education of Mining Engineers." This paper and also our comments appeared in No. 24 of this journal. The nature of the discussion also requires notice. We can only hope that Mr. St. John Durnford had not studied the subject sufficiently to fully understand what his words implied when he said—"If they could get owners "of collieries to insist on having young men who had under-"gone a university education . . . If mining engineers "would take care to appoint and have about them young "men who had been to college . . ." Personally we are in favour of the standard of scientific requirements being raised considerably, but not in the coercive manner suggested by this gentleman. What would he have? A union of mining engineers and colliery managers, which would boycott every colliery owner who refused to employ one of its members. Unions are very desirable institutions if conducted honourably and conscientiously, without prejudice to the employers of its members, but that such an institution should dictate to an employer of labour as to whom he shall and shall not employ is preposterous. Moreover it matters not whether A, B or C college is a students *alma mater* providing he possesses the necessary knowledge. There is no reason why a degree of say M.E. should not be founded to be obtainable by examination, and to have for its object the advancement of scientific education. The colliery managers' examinations might also be made much more difficult and necessitate a deeper knowledge of science, providing no extraneous matter is introduced in the form of such questions as "What is the distance between the earth and the sun" or the answer which a candidate for a civil service post gave, viz.:—"That it was not probable they would come near enough to each other to interfere with his duties," may be taken as a typical answer which it would receive. If a self-taught or semi-self taught student cannot compete with one with a university career in the *necessary* subjects then he must go the wall, and there will be no necessity to request colliery owners to favour this or that class.

THE WORLD'S COAL PRODUCTION.—Mr. E. W. Parker in his report to the United States Geological Survey on "The coal production of the United States" gives the following table shewing the coal product of the principal mining countries of the world:—

COUNTRY.	SHORT TONS OF 2,000 LBS.
Great Britain (1895)	212,320,725
United States (1895)	193,117,530
Germany (1895)	114,524,186
France (1894)	30,273,699
Austria Hungary (1893) ...	33,570,358
Belgium (1895)...	22,507,371
Russia (1893)	8,307,337
Canada (1895)	3,512,504
Japan (1893)	3,400,000
Spain (1895)	1,956,452
New Zealand (1894)	719,546
Sweden (1894)...	235,935
Italy (1894)	299,103
Other countries...	4,126,553
Total	628,805,239

By it we see that the United States is our greatest rival as a coal producing country, and in course of a few years we shall be compelled to resign to them the premier position which this country has held for so long as producing the largest quantity of coal per annum. In 1868 Great Britain produced four times as much as the United States, or, to be more definite, Great Britain produced 103,141,157 long tons, and the United States 28,258,000 long tons. Since that time our production has been considerably increased, but the United States has made such rapid strides that we will shortly be outstripped. In 1895 we were producing only 10 per cent. more. The respective quantities in long tons being Great Britain 189,661,362, United States 172,426,366.

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Note on a Shaft-Fire and its Lesson.*

By Robert Gilman Brown, Bodie, Cal.

THERE are few disasters so difficult to deal with as an under-ground fire. It is inaccessible at best, and generally unapproachable; and it finds most material in the very places where it can do most harm, namely, in large stopes and in "heavy" ground where timbers are massed, and in shafts and level-stations where there are inevitably strong drafts to make the burning yet more fierce. The fire constituting the subject of this note occurred in the shaft of the Standard mine at Bodie, California, and originated after the departure of the night-force at 3 A.M., being discovered by the men going to work at 6-30. At that time it had gained already considerable headway, and was throwing smoke plentifully from the collar of the shaft.

It must be premised, for understanding of the situation, that in this shaft all hoisting is done to the 320-foot level, where the material is dropped by chutes 30 feet to the tunnel-level, through which it is run to the mill. Hoist and sheaves are all placed underground, the upper portion of the shaft being open, but unused. The tunnel is 1800 feet long, and attempts were made at once to reach the shaft through it, but increasing smoke and gas drove the men back a hundred feet and more.

The natural course in such a case is to bulkhead everything as tightly as possible, with the hope that the fire may be smothered in its own carbonic acid, but in this instance the element of uncertainty was too large. There was a nest of old timbers in ore-chutes and shaft, above tunnel-level, where fire would lurk for months; and, more than that, there were a dozen connections through caved stopes to neighboring mines that could not be bulkheaded as well as through openings that perhaps could. The shaft must, therefore, be approached at the ore-chutes on the tunnel-level, if possible; and this might be made possible by leaving the tunnel as the sole free intake. All other openings, to the surface direct and through other mines, were at once sealed, with the hoped-for result. In the course of two hours the chutes could be reached, and a hand-to-hand fight with the fire could be begun. In this struggle important aid was furnished, absurd as it may seem, by hand-extinguishers, and the drug-stores of the town were ransacked for bottles suitable to hold acid, while the assay office furnished the soda for numberless charges. At first water was brought in barrels, and a hand force-pump was used. Later, connections were made from the outside to the mine-pipe which passed out of the tunnel, and water was pumped in, to be thrown upon the fire, through a 2-inch hose, by a small centrifugal pump driven by electricity. The latter arrangement was put into operation on the second day of the fire. By this time the chutes and shaft at tunnel-level had caved down, and the fire in the half-buried timbers had to be fought for a day or two more, the fear being that it would work down the shaft.

Meanwhile water was being pumped from a neighbouring mine through fire-hose into the collar of the shaft, which spattering and spraying down finally saved the upper 200 feet of it.

The damage was ultimately found to extend upwards from tunnel-level, where the cage had wedged, and to include the chutes and hoist-station. This must be regarded, in view of the much greater disaster threatened, as a most fortunate and satisfactory result.

By way of deducing for general application the lessons taught by this experience, it may be well to classify the elements which combined to lessen the injury incurred under the two heads of existing conditions and active relief-measures.

Existing Conditions.—These might well be called adventitious or accidental circumstances, since they can scarcely be said to have been provided deliberately with a view to the emergency in which they came into play. Apart from the conditions involved in the nature of the mine, the locality of the fire, etc., they comprise:

a. The wedging of cage just above tunnel-level.

b. The presence of a water-pipe in the tunnel, with easy outside connections to adequate water-supply.

c. The possession of a centrifugal pump and electric motor that could be put into operation almost immediately.

d. The supply of water from a neighbouring mine, and sufficient hose to bring it to the collar of the shaft.

Relief Measures.—Under this head may be mentioned:

e. The bulkheading of all approaches save one.

f. Fighting the fire with hand-extinguishers.

g. Hauling in water and using hand force-pumps.

These two categories are not food for pleasant consideration, yet it is safe to say that the conditions of 80 per cent. of the metal-mines of the West are to-day no better.

It is clear that the first list, which really made the fight a winning one, deserves special consideration, with the view of converting its elements into relief-measures for future application.

* Abbreviated from the Transactions of the American Institute of Mining Engineers.

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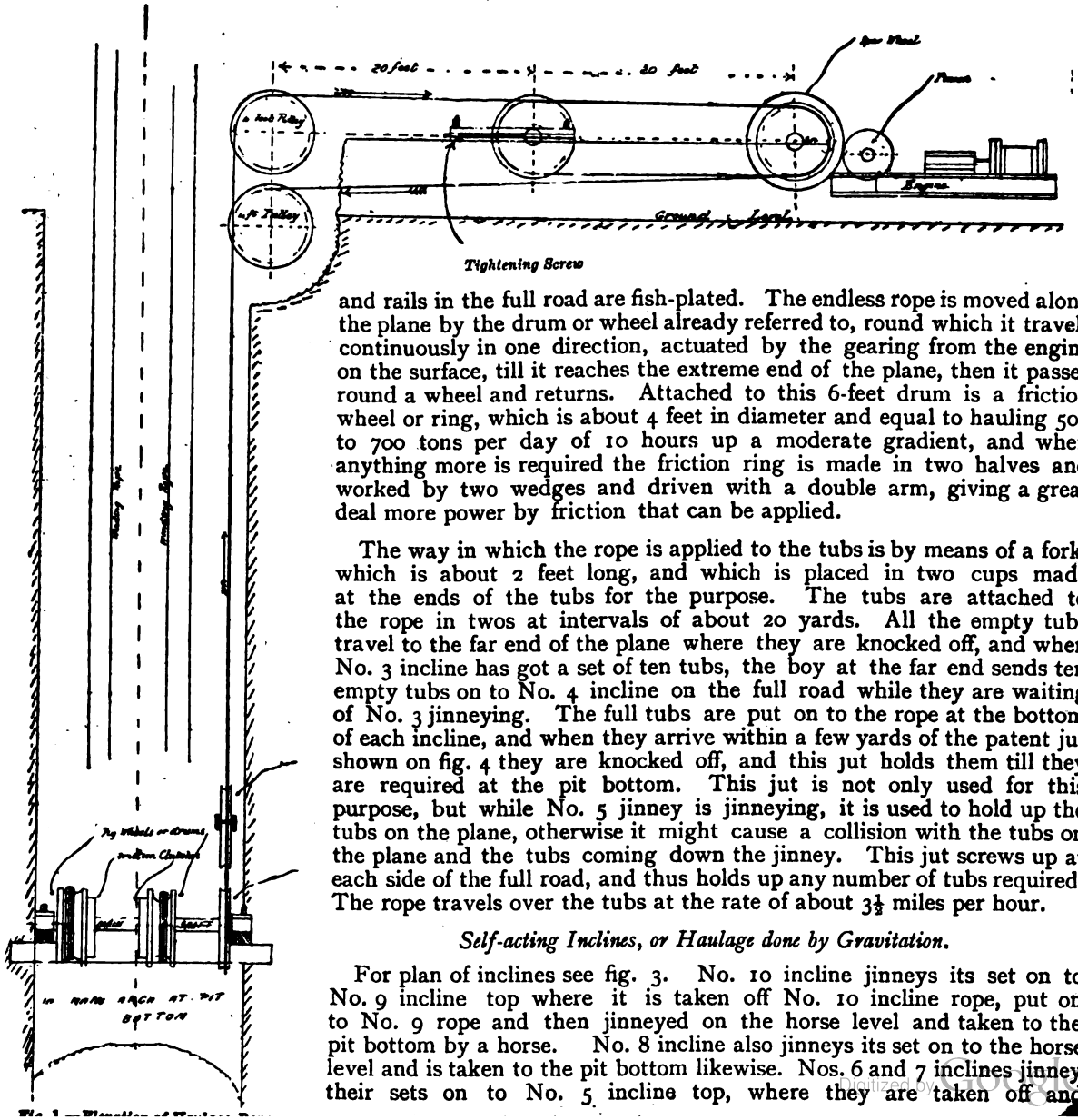
Ireland Colliery, Staveley, nr. Chesterfield.

DESCRIPTION OF UNDERGROUND HAULAGE SYSTEM.

BY R. W. CUTHBERTSON.

System of Haulage adopted and Haulage done by Engine.

THE system of haulage adopted at this colliery is the endless rope. The engine for driving the endless rope is a single and stationary engine, double-acting, 21-inch cylinder, with a 4-foot stroke, and is situated at the surface. The ropes pass round two pulleys, each 4 feet in diameter, at the top of the shaft, and are then carried down the shaft sides in wooden boxes, and passed round two 3 feet pulleys near the bottom of the shaft to guide the rope to the main shaft (see fig. 1). At the bottom of the shaft the rope is passed two and a half times round a 6 feet drum or wheel, this being the main wheel or drum (see fig. 1). The plane rises from the shaft bottom 1½ inches per yard, and is about 1,500 yards long. Two sets of rails are laid all the way, except at the bottom of the inclines where there are three sets, one being used as a siding. The empty road is laid with chairs,



and rails in the full road are fish-plated. The endless rope is moved along the plane by the drum or wheel already referred to, round which it travels continuously in one direction, actuated by the gearing from the engine on the surface, till it reaches the extreme end of the plane, then it passes round a wheel and returns. Attached to this 6-feet drum is a friction wheel or ring, which is about 4 feet in diameter and equal to hauling 500 to 700 tons per day of 10 hours up a moderate gradient, and when anything more is required the friction ring is made in two halves and worked by two wedges and driven with a double arm, giving a great deal more power by friction that can be applied.

The way in which the rope is applied to the tubs is by means of a fork, which is about 2 feet long, and which is placed in two cups made at the ends of the tubs for the purpose. The tubs are attached to the rope in twos at intervals of about 20 yards. All the empty tubs travel to the far end of the plane where they are knocked off, and when No. 3 incline has got a set of ten tubs, the boy at the far end sends ten empty tubs on to No. 4 incline on the full road while they are waiting of No. 3 jinneying. The full tubs are put on to the rope at the bottom of each incline, and when they arrive within a few yards of the patent jut shown on fig. 4 they are knocked off, and this jut holds them till they are required at the pit bottom. This jut is not only used for this purpose, but while No. 5 jinney is jinneying, it is used to hold up the tubs on the plane, otherwise it might cause a collision with the tubs on the plane and the tubs coming down the jinney. This jut screws up at each side of the full road, and thus holds up any number of tubs required. The rope travels over the tubs at the rate of about 3½ miles per hour.

Self-acting Inclines, or Haulage done by Gravitation.

For plan of inclines see fig. 3. No. 10 incline jinneys its set on to No. 9 incline top where it is taken off No. 10 incline rope, put on to No. 9 rope and then jinneyed on the horse level and taken to the pit bottom by a horse. No. 8 incline also jinneys its set on to the horse level and is taken to the pit bottom likewise. Nos. 6 and 7 inclines jinney their sets on to No. 5 incline top, where they are taken off and

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jinneyed to the pit by No. 5. No. 4 incline jinneys its set on to a siding next to the main full road, where they are taken off the incline rope and put on to the endless rope in twos and sent to the pit

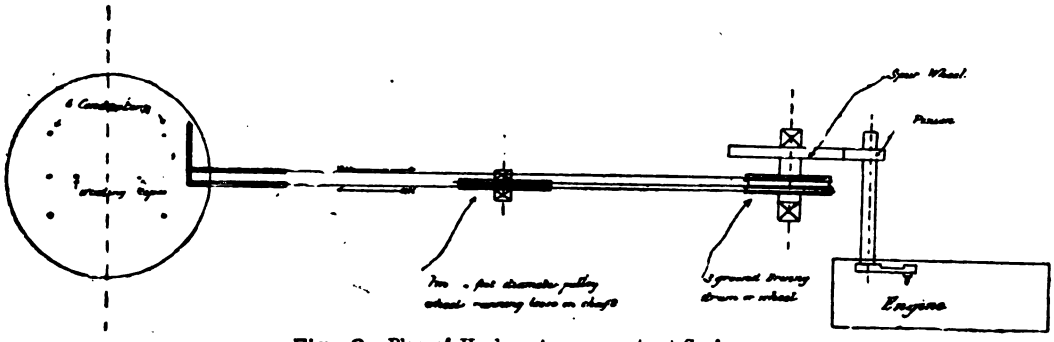


Fig. 2.—Plan of Haulage Arrangements at Surface.

bottom as I have already mentioned. No. 1 incline jinneys its set on to a horse level where it is taken to the top of No. 3 incline and jinneyed down on to the endless rope plane. The rate at which the tubs travel in these inclines is about six miles per hour. The proposed incline extension from the top of No. 3 incline, is to cut off No. 1 incline and the horse level, which will come out in the main district at the far end of the pit. This gate will become an incline some day, and then it will jinney that district's coal on to the proposed incline, and then jinneyed straight away on to the top of No. 3 incline, thus saving a great amount of labour.

Haulage done by Horses.

The tubs are taken from the top of the inclines by horses (in twos) and thus taken to the stalls; then they return to the incline top with two full ones. The boys that have charge of the horses are called putters and paid by the score of tubs they bring from the stalls.

Miscellaneous.

The size of the tubs used on the endless rope plane is as follows:—

INSIDE MEASUREMENTS.

Length ..... 3 feet 8 inches
Width ..... 2 feet 8 inches
Depth ..... 2 feet 2½ inches

Centres of wheels ... 1 foot 4 inches
Width of frame ..... 20½ inches

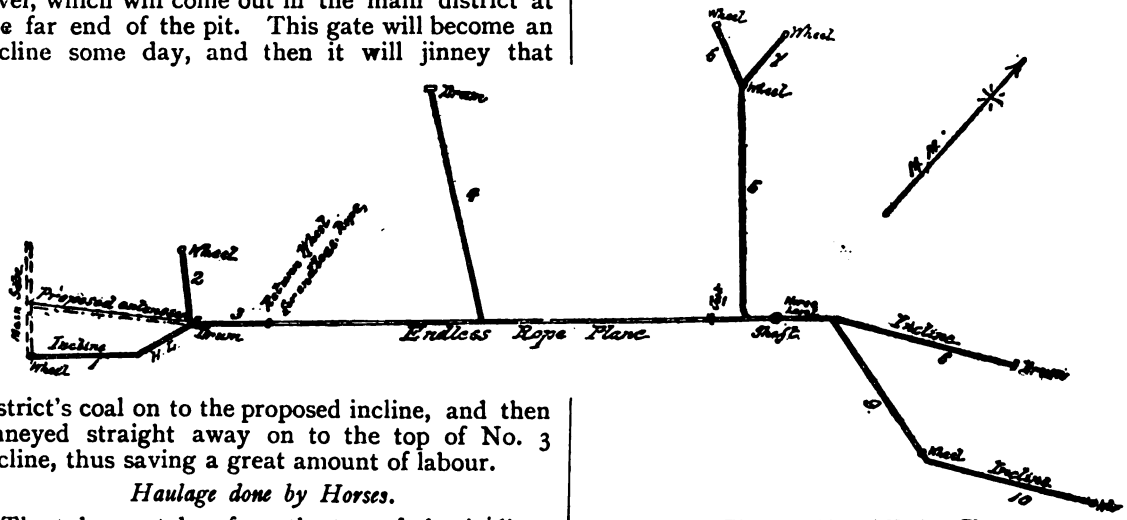
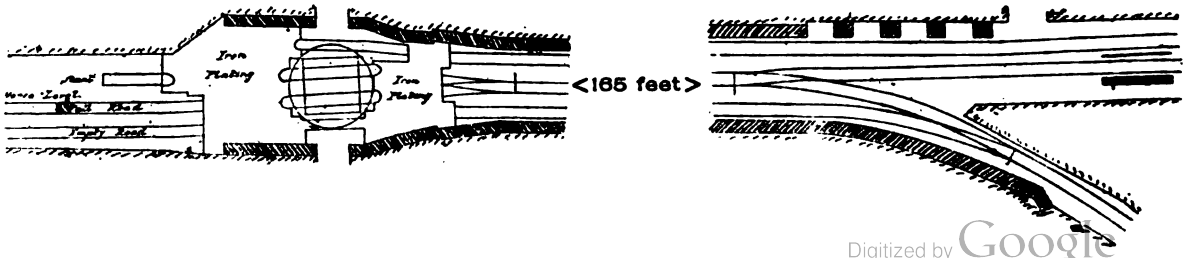


Fig. 3.—Plan of Haulage Planes.

The tubs hold about 10 cwt. of coal. The rails used on the plane and inclines are about 15 feet long and weigh about 30lbs. per yard. The signalling on the endless rope plane is done by electricity. For arrangements of sididgs at pit bottom, &c., see fig. 4.



Scale—85 feet to an inch.

Fig. 4.—Pit-bottom Arrangements.

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The Midland Institute of Mining, Civil and Mechanical Engineers.

IMPORTANT DISCUSSIONS.

A GENERAL MEETING of the members of this institute was held on the 24th ult., at Leeds, when Mr. G. Blake Walker, J.P., president, occupied the chair.

POWDERED COAL FOR FIRING STEAM BOILERS.

The President said the paper by Mr. Bryan Donkin (one of our most eminent mechanical engineers) on this subject was very interesting. It described the use of coal powdered so finely as to go through holes $\frac{1}{16}$ inch in diameter—in fact, somewhat similar to the fine dust which adhered to the props, bars, sides and roof in a pit where it was dry and dusty. They knew that in case of explosion this coaldust rapidly ignited and produced intense heat and flame, and by a contrivance which Mr. Donkin mentioned, and particularly the Wegener system, this fine dust was used to produce very excellent results in boiler furnaces. The boiler efficiency with this finely-powdered coaldust was as high as 78 per cent., the efficiency of boilers fired with nuts being only 54 per cent. Analyses of the gases resulting from combustion showed a higher percentage of carbon monoxide than was usual, consequently raising a more intense heat, and finally the whole of the smoke was consumed. They had a great deal of small coal to deal with, and as pits got deeper coal was apt to become more dusty. If any of these contrivanccs for burning very fine coaldust could be brought into general use, it might very much improve the value of small coal, which at present was almost valueless. Apart from that, it might be worth while at some collieries to consider the question of utilising the small coal in some such way as this. It appeared that nut coal was ground at a cost of 9d. to 1s. per ton for the experiments dealt with in the paper.

Mr. Nash pointed out that stuff worth 5s. 6d. a ton was used at a cost of 9d. per ton for grinding, whilst at many collieries they fired with stuff worth 1s. 6d. per ton. The question was how they were going to obtain a difference of results to compensate for the difference in cost. As to the consumption of smoke they could get smokeless chimneys if they had plenty of boiler room to fire gently.

The discussion was adjourned.

HOW A MINE MAY BE DRY BUT NOT DUSTY.

A short discussion on Mr. G. Fowler's paper on this subject took place, and it was pointed out that the dressing and smoothing of the sides of the roads in the pit which the author proposed might be practicable at Cinder Hill Colliery, but were altogether out of the question in the constantly shifting state of the mines in Yorkshire. Sprinklers were spoken of as apt to be a source of trouble, the moisture which seemed to do no harm at first eventually causing numerous falls of roof and sides.

Mr. E. W. Thirkell said he intended trying the experiment of moistening the dust from the screens and surface works, a large quantity of which was borne into the mines on the air-current, thus contributing to no small extent to the quantity of dust in the mine.

The discussion was adjourned.

THE EDUCATION OF MINING ENGINEERS.

The president's paper on this subject came up for discussion.

Professor O'Shea, of the Firth College, Sheffield, who was unable to be present at the meeting, wrote saying that in South Yorkshire for the last six years they had been dealing with the subject of elementary mining education, and they were now advancing a step further in providing for the educational wants of mining engineers. He believed in the future only those engaged in our great industries would succeed who were able to use to the greatest advantage the resources of science not only in dealing with the primary commodity, but in the treatment and recovery of all attendant by-products. He who had the best scientific and practical training would be the one to do this. At home they had practical training, and without reducing that he would strengthen it by thorough scientific training. The initiative in this must come from the mining engineers. From his experience in South Yorkshire and North Derbyshire he felt that if active and sympathetic interest were shown in this matter by those in authority it would be possible to conceive and carry out a system of training for mining engineers which would help them to compete with their neighbours abroad. Referring to German enthusiasm for scientific education, he said the highly-educated engineers controlling the German mining industry recognised the advantage of having men similarly trained around them. With similar hearty co-operation of mining engineers at home and some recognition from the authorities, the enthusiasm so evident in Germany would come to them in this country. He agreed that Government should be asked to recognise the time spent by mining students in attending a properly-organised college course of study during the period of their articles, and suggested the institute should send a deputation to the Home Secretary on the subject. He pointed out how at the Firth College a system of training for mining students similar to that given at the college in Newcastle was now available for mining students.

The President said he should like the members of the institute to identify themselves with him in taking up this subject. He hoped they would try to come to some conclusion as to what was desirable, and how they could give effect to it.

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Mr. Mitchell (secretary) said the difficulty was the want of enthusiasm amongst the men themselves. In the classes at Barnsley, carried on in connection with the Yorkshire and Firth colleges, very few had availed themselves of the opportunities offered. He agreed that when they found any young men about the pits who appeared likely to read, they should encourage them to avail themselves of the existing opportunities. The course at Barnsley, including the surveying class, was everything that a man could wish if he would do a little work at home.

Mr. E. W. Thirkell concurred as to the value of the education given, and said he had himself attended the course with a view to encouraging his deputies and others to attend. Good might be done if the managers would try to induce their deputies and officials to use these classes.

Mr. J. L. Routledge (Leeds) pointed out the advantages of the classes other than those of the Yorkshire college at Leeds.

Mr. St. John Durnford said they wanted to emphasise as much as possible the fact that there was a systematic course for articled pupils at the Firth College and the Yorkshire College, altogether independent of the evening classes which could be attended by people at local centres. The fact of articled pupils attending these classes, as he believed had been stated by the inspector of the district, would not disqualify them from counting their time as given in for certificate examinations. If they could get owners of collieries to insist on having young men who had undergone a university education they should have accomplished a great deal towards getting the scientific requirements they wished for. If mining engineers would take care to appoint and have about them young men who had been to college, that would go a long way towards putting them on a level with the Continental schools of mines.

Mr. Bonser deprecated the spirit of self-depreciation which was so prevalent, and challenged comparison of the English and foreign methods of mining.

Mr. Nash insisted on greater care being taken to suit the matter taught to the capacity of the pupil.

The President said great pains were now taken by the teachers in that direction.

The discussion was adjourned.

"MINING ENGINEERING,"

First Issue November 28th, 1896.

PRICE TWOPENCE.

OF ALL NEWSAGENTS.

Coal Mining in India.*

UMARIA MINE.

The Government of India own this mine.

Inspections and Reports.—Regular inspections of the different parts of the mine are made by the mine officials; and a daily report on a printed form is made by the deputy overman on general matters affecting safety and the working of the mine. The foreman mechanic reports on the machinery, and the underlookers make a note in a book kept below ground on anything they think requires attention. No reports are made of shaft inspections, though the inspections are said to be regularly made. All the workmen, and nearly all the officials, go in and out of the mine by way of the inclines.

System of Working.—The No. 2 seam is 6 to 7 feet thick, and the No. 3 seam averages 7½ feet thick. The system of working out the coal is the bord and pillar or pillar and stall system. The coal pillars are being worked out ("work in brokens") by first driving roads through the pillars (the full height of the seam) to split up the pillars into convenient sized portions. Then the pillars are worked out in vertical slices in the same order as in the bords. The roof requires to be thickly timbered behind the working faces, but the timber is drawn out again as soon as a portion of a coal pillar has been worked out; and the roof breaks up and falls either as soon as the timber is withdrawn, or partly then and to a much greater extent when a number of pillars together have been removed. But though the timber is supposed to be withdrawn, so far as is safe, as the pillars or coal are worked out, there is a quantity of timber irretrievably lost.

Ventilation.—The ventilation is principally provided by a Schiele fan 9½ feet diameter, and from 20 inches to 4 feet wide, running at about 90 revolutions per minute. The fan, driven by a single condensing engine, and rope gearing, is said to be capable of producing 75,000 cubic feet of air per minute when running at 90 revolutions per minute. The air-doors used in the mine are made by covering a wood frame with galvanised iron, and swinging this in another wood frame built in brick walls. Brattice doors are also used, and made by fixing two props under a cross-bar to the roof, and firmly nailing the hanging sheet to the bar, and closing the sides from the props to the coal by other nailed sheeting.

* From Mr. Grundy's H.M.I.M. Report.

Answers to Correspondents.

R.M. and Others.—We shall be pleased to publish, and moreover, to pay for good descriptive and illustrated articles on modern collieries. When required the Editor will give his assistance in the writing and arrangement, and will have the sketches suitably drawn for reproduction.

T.R.N.—We purpose publishing illustrated articles on "Modern Coal-Washing Apparatus," in the early numbers of "Mining Engineering." Particulars of work done by existing plant will be appreciated.

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The Coal Production of the United States.*

THE output from the coal mines of the United States in 1895 exceeded that of any previous year in the history of the country, aggregating 172,426,366 long tons of 2,240 lbs., equivalent to 193,117,530 short tons of 2,000 lb. This was an increase of 22,376,004 short tons over the product of 1894, or an advance of about 13 per cent. The year of largest production previous to 1895 was 1893, when 182,352,774 short tons were mined. The output of 1895 exceeded this by about 10,000,000 tons, or a little more than 5 per cent. The coal product comprises all got including that consumed at the mines. Coal consumed in the manufacture of coke is also included in this report. Excluding the colliery consumption, the product in 1895 was 169,389,630 long tons, or 189,716,386 short tons.

Anthracite Production.—The product of Pennsylvania anthracite in 1895 was 51,785,122 long tons, or 57,999,336 short tons, valued at 82,019,272 dols. This was the largest output ever obtained, being 5,426,978 long tons, or about 11 per cent., in excess of that of 1894, and 3,599,816 long tons more than in 1893, the year of largest previous production. The value in 1895, however, while greater than that of 1894, was comparatively less, and there were four years prior to 1895 when, with a smaller output, the value was in excess of the year just closed. These years were 1887 (84,552,181 dols.), 1888 (89,020,483 dols.), 1892 (82,442,000 dols.), and 1893 (85,687,078 dols.). The average price per ton, obtained by dividing the total value by the total product, was 1·69 dols. per long ton in 1894 and 1·58 dols. in 1895, a decline of 11 cents. In quoting the average price per ton of anthracite, however, the item of colliery consumption is excluded as not having any value, only the marketable product being considered. The average price for the marketable grades was 1·85 dols. in 1894 and 1·72 dols. in 1895, a decline of 13 cents. In 1893 this average price was 1·94 dols. Two reasons may be assigned for this decline, both of which probably had some effect—one of general depression in values, whose influence was felt in all branches of trade; the other the increased use of the smaller sizes of anthracite, which are sold at lower prices, and cause a comparative decrease in the total value of the coal marketed. As these sizes were previously a waste product and have now become a source of revenue, there is, in the product affected, an increased profit from the coal mined, though a decreased value for the coal marketed. The number of men employed in the anthracite mines in 1895 was 142,917, who averaged 196 working days, against 131,603 men for 190 days in 1894.

In addition to the anthracite production of Pennsylvania in 1895 there were 67,179 short tons mined in Colorado and New Mexico, making the total output of anthracite coal in the United States 58,066,516 short tons.

Bituminous Coal Production.—The production of bituminous coal in 1895 (including lignite, brown coal, and scattering lots of anthracite, was 135,118,193 short tons, valued at 115,779,771 dols., compared with 118,820,405 short tons, valued at 107,653,501 dols., in 1894 indicating an increase in product of 16,297,788 short tons, or 14 per cent., and in value of 8,126,270 dols., or 8 per cent. The total number of men employed in the bituminous coal mines in 1895 was 239,962, averaging 194 working days, against 244,603 employés for 171 days in 1894.

The Coal Output of the United States and Great Britain compared.—The following table shows the production of coal in the United States and Great Britain during the last sixteen years:—

Year.	United States. Long tons.	Great Britain. Long tons.
1880 ...	63,822,830 ...	146,969,409
1881 ...	76,865,357 ...	154,184,300
1882 ...	92,219,454 ...	156,499,977
1883 ...	102,867,969 ...	163,737,327
1884 ...	106,906,295 ...	160,757,779
1885 ...	99,069,216 ...	159,351,418
1886 ...	100,663,753 ...	157,518,482
1887 ...	116,049,604 ...	162,119,812
1888 ...	132,731,609 ...	169,935,219
1889 ...	126,097,780 ...	176,916,724
1890 ...	140,882,729 ...	181,614,288
1891 ...	150,505,954 ...	185,479,126
1892 ...	160,115,242 ...	181,786,871
1893 ...	162,814,977 ..	164,325,795
1894 ...	152,447,791 ...	188,277,525
1895 ...	172,426,366 ...	189,661,362

Cost of Coal Mining.—In collecting the statistics of coal production in 1895 an effort was made to ascertain approximately the relative cost of mining bituminous coal, the total expenses and the total value. The effort was only partially successful, but enough information has been obtained to form a basis for a fairly accurate estimate. A statement was prepared from information received from 425 mines producing over 10,000 tons each, and having a total outpnt of 34,535,000 tons, or about 25 per cent. of the entire bituminous coal product. The total selling value of the product of these mines was 32,661,750 dols., an average of 95 cents per ton, against an average price of 86 cents for the total bituminous coal product. The average wages received by the miners varied from 30 cents per ton in West Virginia to 78 cents in New Mexico, the general average being 48 cents, or practically exactly half the selling price. The rate of wages paid to the miners represented 64 per cent. of the total expense of mining the product and placing it

* From a report by Mr. E. W. Parker to the United States Geological Survey.

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on cars for shipment. This makes the total expense average 75 cents per ton, not considering the interest on invested capital. The total expenses computed as above for the 425 mines amounted to 25,970,110 dols. The capital invested in these mines was approximately 80,000,000 dols., on which an interest charge of 6 per cent. would be 4,800,000 dols., making the total expenses chargeable against the tonnage 30,777,110 dols., and the actual net profit to operators less than 2,000,000 dols. Applying the same averages to the total bituminous product in 1895, it will be seen that out of 115,779,771 dols. received for the coal there was paid out for mining coal 66,688,160 dols., and the total expenses about 104,000,000 dols. Interest charges, based on a capitalisation of 320,000,000 dols., would bring the total charges up to 123,200,000 dols., more by 7,500,000 dols. than the amount received. Leaving out the item of interest charges, there remains, after paying the other expenses, a balance of about 11,780,000 dols. as the income of an invested capital of 320,000,000 dols., a little more than 3½ per cent.

THE PROGRESS OF ENGINEERING.

THE seventy-eight session of the Institution of Civil Engineers was inaugurated on Tuesday the 3rd prox., by the presidential address of Mr. J. Wolfe Barry, C.B., F.R.S., delivered in the lecture theatre of the new building, in Great George Street, Westminster. Mr. Wolfe Barry remarked they met under circumstances which marked the year 1896 as an epoch at which the president of that institution might offer some remarks, not in the nature of a review of any of the various recent feats of engineering, but rather as a retrospective survey of the general progress with which engineering had been and was intimately connected. The material advances which the country had made during the Queen's reign were so remarkable and had depended so much on engineering developments and progress that they might at such a time as the present survey with profit the period covered between the accession in 1837 and the present time. No one could deny that the intervening years constituted the most important period yet known of engineering, or that the work of engineers during this period had had most far-reaching effects upon the material interests of the inhabitants of these islands, as, indeed, of the world at large, whether those effects had been produced by improved means of intercommunication by land and sea, of sanitation. or of labour-saving appliances. Having noted the rapid increase of the urban population in Great Britain since the Queen's accession, the president reminded the members of the institution, that, although a short time prior to that period the Stockton and Darlington, the Newcastle and Carlisle, the Liverpool and Manchester, and some isolated railways had been opened and worked by locomotives, and several railways had been worked by horses before the introduction of locomotives, none of the main arterial lines had been opened; and it was not till 1837 that the Grand Junction Railway connected Liverpool with Birmingham, nor till 1838 that the London and Birmingham line was completed. The railway capital expended up to 1837 was, perhaps, 30 millions, and applications were before Parliament for new railways estimated to cost 28 millions, but the mileage actually opened probably did not reach to the length of 1,000 miles. The capital up to the present moment expended was 1,000 millions sterling, and the mileage worked was upwards of 21,000 miles. Practically speaking, therefore, the railway system of these islands, which was many years in advance of other countries, had been developed in the Queen's reign. The management of the lines was for many years anything but enterprising. All but the express trains were slow, and the third-class accommodation little better in point of comfort and worse in respect of speed than that of the present cattle trains. The one idea seemed to be to discourage, by all the ingenuity of the railway managers (which seemed to have been then, as now, very considerable), what had now been proved to be the backbone of passenger traffic—namely, that of the third class. In 1872 his valued friend the late Sir Jame Allport induced the Midland Railway Company to cultivate the third-class traffic by attaching third-class carriages to all their best trains, and by reducing all their third-class fares to 1d. per mile. That policy would have been delayed for many years and, perhaps, would not even now have been inaugrated, but for the enlightened views and sagacious firmness of Sir James Allport, who in the matter had an uphill fight with the general managers of other railways, and even with his own directors. Before his death in 1892 Sir James Allport told him of this struggle, and said that had he been a younger man he would have endeavoured to carry a tariff of ½d. per mile for third-class and 1d. per mile for first-class passengers. He had little confidence in the renovation of transit by inland canals, because it was slow, deficient in power of convenient distribution, and necessarily uncertain, as largely depending on rainfall, and liable to be entirely deranged by prolonged frost. He did not, however, wish it to be understood that this remark applied to inland ship canals, though even by these waterways the results hitherto realised were very disappointing. If so much progress had been made in locomotion on land during the Queen's reign, how great had been the improvements in transit by sea! Although the "Savannah," an American ship, with small auxiliary engines, had in 1819 crossed the Atlantic in about a month, such a voyage, if attempted by vessels entirely or

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mainly dependent on steam, was at the date of the Queen's accession considered by high authorities to be a mathematical impossibility. Nowadays the journey to New York occupied a little over five days, being performed at an average speed of twenty-one knots per hour by vessels of 12,000 tons, with engines of 30,000 horse-power. The dimensions of the "Pennsylvania," just launched at Belfast, dwarfed even those of the "Great Eastern," the only fault of which latter vessel was that she was before her time. It was lamentable and reflected little credit on the foresight of some of them, that the "Great Eastern," whose hull had excellent lines, and was nearly as good as new, should have been broken up for old iron only eight years ago. After a brief reference to the great strides made by the mining industry during the Queen's reign—the total output of coal having increased from 65 millions of tons in 1854 to about 190 millions of tons in 1895—Mr. Wolfe Barry showed that the number of letters and newspapers delivered by the Post Office had risen from 100 millions and 70 millions respectively in 1837 to 2,560 millions of letters and post cards and 1,200 millions of newspapers in 1895. Having chronicled the progress made in submarine telegraphy—by incidental allusion to the facts that prior to 1851 there was no submarine cable across the Channel, none to the United states till 1858, nor to India, Australia, or South Africa till 1865, 1872, and 1879 respectively, whereas now the mileage of submarine cables was 162,000 miles, the capital employed in them is 40 millions, and the total number of foreign and colonial telegrams about seven millions annually, without reckoning those sent by the submarine companies without the intervention of the Post Office—the president glanced shortly at some of the statistics relating to sanitary engineering. The reduction in the mean death-rate of London, amounting to almost five per 1,000, meant a saving of life in the metropolis alone of 22,000 individuals annually—a result very largely due to the efforts of the sanitary engineer, though it was, of course, to be partly accounted for by better wages, better organisation, and better medical education. If the same rate of reduction obtained in the thirty-six largest towns of the kingdom, including London, it might be claimed that 60,000 lives were annually saved by these causes in those towns alone. Though much of the reduction of the death-rate in towns might properly be attributed to improved sewage, that cause was by no means of equal importance to an ample supply of good water. In this direction immense progress had been made during the Queen's reign. The cheapening and universal application of gas to towns and large villages marked another engineering success of the Queen's reign, and lately its use for heating purposes was a further most important step. The work accomplished by the electrical engineer during the latter half of the Queen's reign was a subject full of interest Electric traction had now passed through the experimental stages, and might be looked upon as an accomplished idea. They had the facts that the South London railway and the Liverpool railway had been and were being worked electrically at this moment; that a French railway company had been working a full-sized train for months between Paris and Mans by an electrically-actuated locomotive, though the electricity was generated on that same locomotive, and not conveyed by a conductor; that the Baltimore and Ohio Railway Company of America had constructed and worked an electric locomotive weighing about 90 tons, actuated by electricity conveyed to it by a conductor; and that thousands of miles of tramways were worked by the same means. No doubt the application of electricity to the working of heavy trains under the exigencies of such traffic as that on the Metropolitan and District railways would involve some new problems and require much consideration; but he thought the time had come for the work to be faced, and he was persuaded that, large as the necessary capital required might be, it would be well spent. He drew attention to the work recently inaugurated at Foyers for the employment of water power in the production of electricity for the manufacture of aluminium out of bauxite, and said that the success of the scheme showed that a great future might remain for the use of water power, not only in the manufacture of aluminium, but also of acetylene and other products which might attain to much importance. Having directed attention to the work of the engineer as applied directly to domestic life, the president remarked that in the history of the present year a subject of special interest was the new departure authorised by Parliament in the Light Railways Act, and what might be called the "Automotor Emancipation Act" of last Session. He had little doubt that light railways would, in many districts, be of great utility, and earnestly hoped for, and fully expected, at the hands of the commissioners appointed, a well-considered policy. Much would depend on the inauguration of the system on sound lines. He held strongly that light railways should in all cases, other than where they would be independent approaches to a port or to a market, be the same guage as the standard gauge of the country. Mr. Wolfe Barry concluded his comprehensive retrospect by tracing the gradual expansion of the Institution of Civil Engineers. He dwelt at length upon the special training required by engineers, and strongly urged that qualifying (not competitive) examinations should be introduced by the institution for the degree of associate member.

Indexes, Bound Volumes, and Cases for present Volume (IV.), ready shortly. Particulars next issue.

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Examination Questions with Answers.

By JOSEPH CARTER, First-class Certificated Manager.

Questions given at the Examination for Certificates of Competency for the West Lancashire & N. Wales District, June, 1895, at Wigan.

FIRST-CLASS.

(Continued from last issue.)

Part II.—Mine Working.

QUES. 18—In consequence of the stoppage of an adjoining colliery, you have to deal with an additional flow of water which passes through a considerable length of goaf of a mine in which a large quantity of iron pyrites exists. What precautions would you take in preparing for and dealing with such water?

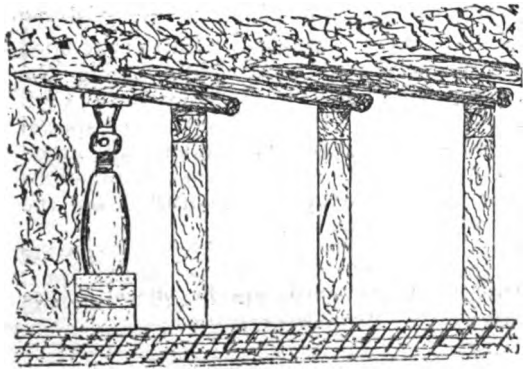
ANS.—In consequence of the existence of a large quantity of iron pyrites in the goaf of the mine, water coming in contact with the sulphide of iron, or iron pyrites takes up in solution the sulphur and forms sulphuric acid, which corrodes the pumps it has to pass through unless prevented by some means. Different methods have been tried to overcome this difficulty, such as steeping the pipes at a red heat in coal tar, which fills up the pores of the metal and prevents the corrosive action of the water, The valves and valve seating must also be protected from its corrosive action, and for this purpose they are better made of gun metal, and the pumps lined with thin staves of hard wood such as oak. If possible, the water should be carried through the goaf in pipes, so as not to allow it to come in contact with the iron pyrites.

QUES. 19—What are the requirements of the Coal Mines' Act as to explosives?

ANS.—See General Rule 12, C.M.R.A. with its sections and sub-sections.

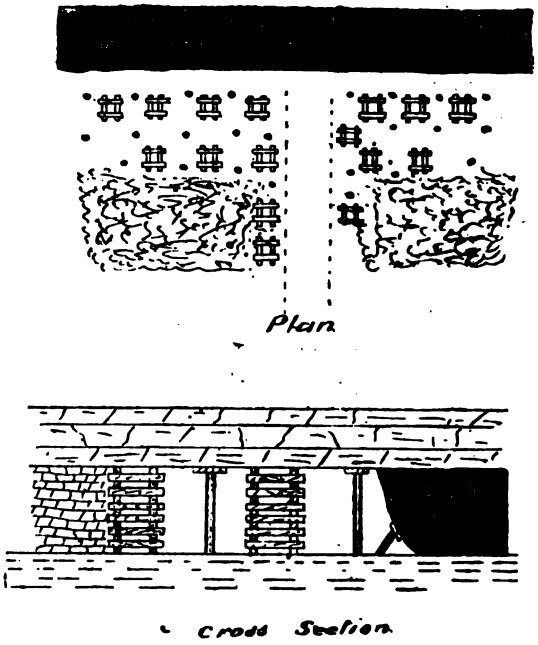
Timbering.

QUES. 20—In cleaning up through a heavy fall in a main haulage road, show how you would secure the roof where it has come down for a considerable and unknown height in faulty ground and what precautions you would take?



ANS.—I should commence at the front end of fall and set a couple of strong bars, making them very secure; then I should drive long piles over these and into the fallen material, the end of the piles slightly pointing upwards, so as to give room for the next set of bars to be erected and driven on. When the first lot of piles have been driven on commence to remove the dirt, and during its removal the piles are supported by props until room is made for another set of bars to be erected. Sometimes it is necessary to have a screw jack at hand so that if the ends of the piles are to low they must be raised by it so as to leave room for the next set of timber to be erected, leaving sufficient room for the piles to go over them. As a precaution against accidents I should have thoroughly experienced men, because in such cases as these great care is required.

QUES. 21—Show by sketches (plan and section) how you would timber the working face on the longwall system in a mine 500 yards deep, and when the coal is 4 feet thick, showing upbrow at an inclination of 1 in 10. Give the distance you would set the props and sprags apart.



ANS.—The method of timbering the working face of a mine depends very much on the nature of the roof. Take an ordinary kind of roof (hard shale) the sketches show the method of timbering I would adopt. Props to be set 4 feet apart and a double row of chocks along the faces. Sprags to be set 6 feet apart or at a less distance if required. When timber is set in a systematic order it is easier and safer to draw. The roadways at the face should be secured by bars set across the roadway.

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QUES. 22—What are the requirements of the law with regard to the setting and withdrawal of props? Do you consider that further regulations are necessary?

ANS.—See General Rule 22, C.M.R.A., and Special Rules 47 and 48.

I consider that further regulations are necessary such as a systematic setting of timber, and in the withdrawal of such it should be compulsory for the person so employed to use the gablock and chain, and such person be appointed for the purpose.

Surveying.

QUES. 23—What matters are the most important to record on a colliery plan?

ANS.—Faults, dip, boundaries, important buildings, and the course of ventilation ought to be marked; also a section of the mine and the depth of seam.

QUES. 24—How often do you consider meridians should be taken to ensure the accuracy of colliery plans, and what has to be remembered in connection with this?

ANS.—The meridians should be taken once at least every twelve months and at every important survey. It must be remembered that owing to the magnetic changes of the meridian, we should have errors in our plans unless we took them afresh as stated above.

QUES. 25.—Show by sketch how you would book an underground survey.

See Vol. II, page 254.

Shafts.

QUES. 26—In sinking a shaft which has to pass through several seams of coal, state how you would ventilate it, and what precautions you would take

ANS.—I should ventilate it by means of pipes taken down the shaft; always having plenty on hand ready to be put on when required. I should have a small fan, say 4 feet diameter, which would be quite sufficient for ventilation in sinking a shaft. Precautions I should take, are, that when within several yards of each seam I would bore two or three holes in advance, so as to relieve the pressure of gas from the coal. Keep a good supply of fresh air at the bottom of the shaft. Safety lamps to be used by the sinkers, and non-inflammable explosives to be used. Shaft should be examined by the foreman sinker or competent person by means of a locked safety lamp before the sinkers descend and a report made in a book kept at the pit for the purpose. The lining of the shaft to be kept well up.

QUES. 27—If you had to repair the brickwork in an upcast shaft, what sort of scaffold would you use?

ANS.—The Galloway.

See description and sketch. Vol. IV. page 11.

QUES. 28—Describe and show by a sketch how you would lay

(*a*) A bricking ring.
(*b*) A water ring in a sinking pit.

See explanation and sketches in Vol. II, page 268.

(*Concluded.*)

Answers to Competition Questions

GIVEN IN NO. 23, VOL. IV.

VENTILATION.

(1) A fan running at a certain speed with its ear closed produced a total W.G. 4 inches. With the ear open to the mine and running at the same speed it passes 20,000 cubic feet per minute, with an efficient W.G. of 3·75 inches. By splitting the air-current in the mine, the fan running at the same speed produces 60,000 cubic feet per minute. What will be the W.G.?

Answer.—The fan running with its ear closed to the mine produces a W. G. of 4 inches; with ears open to the mine it produces a W. G. of $3\frac{3}{4}$ inches, therefore R = $\frac{1}{4}$ inch due to fan resistance. Now the pressure varies as the quantity squared—

$\therefore$ as $20{,}000^2 : 60{,}000^2 :: \frac{1}{4}$ in. is to probable W.G.
$= 2^2 : 6^2 :: \frac{1}{4}$ in.
$1 : 3^2 :: \frac{1}{4}$ in.
as $1 : 9 :: 2{\cdot}25$ W.G.

Then 4 in. — 2·25 in. = $1\frac{3}{4}$ in. probable W.G.

JOHN LYLE.

(2) What must be the size of a low pressure cylinder for a high pressure cylinder, 12 inches in diameter by 20 inches stroke. Steam pressure 140 lbs. per square inch, to be cut off at $\frac{2}{5}$ths stroke. Equal work to be done in each cylinder. What is the terminal pressure?

Answer.—First we will get the terminal pressure. Steam enters the H.P. cylinder at 140 lbs. pressure and is cut off at $\frac{2}{5}$ths.

$$\therefore \frac{140 \times 2}{5} = \frac{280}{5} = 56 \text{ lbs. pressure at end of stroke.}$$

Therefore when the steam enters the L. P cylinder it is equal to 56 lbs. pressure, but it is also cut off at $\frac{2}{5}$ths stroke—

$$\therefore \frac{56 \times 2}{5} = \frac{112}{5} = 22{\cdot}4 \text{ lbs. terminal pressure.}$$

$140 \div 22{\cdot}4 = 6\frac{1}{4}$ number of expansions.

To find the proportion of cylinders the following is a good rule:—Determine the initial and final pressures, divide one by the other, the result will

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be the number of expansions. Then get the square root of this number of expansions, and as the root is to the square so must the H. P. cylinder be to the L. P. cylinder, and as the root is to the square so must the point of cut off be to the full length of the stroke.

$\therefore \sqrt{6{\cdot}25} = 2{\cdot}5$, and as $2\frac{1}{2} = 6\frac{1}{4} :: 2 \div 5$.

Therefore the H. P. is to the L. P. as 2 is to 5.

H. P. cylinder = 12 inches, $\therefore$ area in square inches $= 12 \times 12 \times {\cdot}7854 = 113{\cdot}0976$ square inches.

$$\therefore \sqrt{\frac{5 \times 113{\cdot}0976}{2 \times {\cdot}7854}} = 19 \text{ nearly.}$$

Therefore L. P. cylinder = 19 inches and terminal pressure = 22·4 lbs.

JOSEPH MOLYNEUX.

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(3) If the sides of a circular shaft 200 yards deep suddenly collapsed to such an extent that the whole of the bricking had to be renewed, as portions of the walling was constantly falling out, rendering it impossible to go down the shaft, how would you proceed?

Answer.—In such a serious case as is here mentioned, I would at once have the winding ropes detached from the cages, and the cages removed out of the shaft. I would then proceed to fill the shaft up with ash or some other suitable rubbish which would be easy to excavate again. One of the winding ropes should then be rolled on to the drum and clamped, and to the other one a kibble attached for removing the materials to the surface, as the renewing of the bricking is proceeded with, and also for sending bricks, mortar, cement, &c., down to the wallers. I would then take out the bricking (commencing from the top) for some distance down the shaft, securing the sides with cribs and backing deals fixed with chains to beams laid across the shaft until a good hard bed of stone was reached. Here I would prepare a level bed to receive a broad walling curb, and from this curb I would commence walling the shaft up to the surface, packing the spaces behind the brickwork with rubbish. The sides of the shaft above the walling curb should be cut back and built in with bricks, so that this upper portion of walling would be resting on a strong foundation, and would not require chains to keep it up until the bricking below was built up underneath the walling curb. The taking out of the brickwork and removing the rubbish to the surface is then proceeded with in the same manner as before until some distance down when another bed is made for a walling curb, and the shaft built up underneath the last walling curb. This process is carried on until the shaft bottom is reached when the walling is completed. A bricking scaffold should be used for the wallers to stand on, and should be raised and lowered by means of a capstan engine. THOMAS HILL.

Awards.

FOR ANSWERS TO COMPETITION QUESTIONS.

Question 1.—John Lyle, Jordan Hill, Partick, Scotland.

Question 2.—J. Molyneux, 30, Close Street, Castle Hill, Hindley, near Wigan.

Commended.—J. G. Bell, Evenwood, Bishop Auckland; Hy. Causey, 28, Alma Terrace, Bottling Wood, Wigan.

Question 3.—T. Hill, Crosby Villa, by Maryport, Cumberland.

Commended.—J. Jones, Pelydfrynn, Aberderfyn, near Ruabon; R. Forster, 13, Newbottle Row, Houghton-le-Spring, R.S.O., Durham; W. Mitchell, Dalharco, Patna, Ayrshire, N.B.; H. Causey, 28, Alma Terrace, Bottling Wood, Wigan; W. Mullins, Eastwood, Notts.

Correspondence.

HAULAGE.

Sir,—Will any of your able readers kindly answer the following:—

A dook with varying gradient (average 1 in 9), 700 yards long, starts half a mile from the pit bottom; output 250 tons in 8 hours; hutches weigh 4 cwt. Describe with details the method of haulage. Also

What H.P. of engine is required to draw 200 tons per day from a dook dipping 6 inches per yard, a ¾-inch rope being used? If you know of any other method which could be adopted, state it, and describe the same. J. BLACK.

Sir,—An answer to the following will oblige:—

Suppose you have an endless rope haulage system, (1) a level main road 1000 yards long, passing 100 tons of coal an hour; (2) a branch road 2000 yards long, dipping 1 in 12, and passing 25 tons an hour; (3) two branch roads each rising 1 in 12, each 1500 yards long, and each passing 37½ tons an hour. Find approximately the load and horse-power of each road, the tubs to weigh 4 cwt., empty, and 14 cwt. full, and speed in every case 4 miles per hour, and double roads. NEMTRON.

THE BUILDING OFF OF GOB FIRES.

Dear Sir,—Will any of your kind readers give some good practical ideas on building off gob fires in mines; and clearly illustrate with sketches the best kind of stoppings and best method of putting such stoppings in? J.B.Z.

[Awards will be made for published answers to the above questions.—ED.]

MENSURATION.—A CORRECTION.

Sir,—I was very pleased to see John N. Wardle's answer in this week's issue of your paper, and beg to inform you that myself and fellow students have gained useful information from his answers to questions which have been given. I beg to correct a slight error in the answer to the above question.

The area of the seam in square feet = 17,511,120.

Thickness of the seam is 3½ feet; therefore the number of cubic feet = $17{,}511{,}120 \times 3{\cdot}5 = 61{,}288{,}920$ cubic feet of coal; and as 32 cubic feet are equal to a ton, $61{,}288{,}920 \div 32 = 1{,}915{,}278$ tons, 15 cwts. ROBERT P. HUNTER.

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